

**THE TAMIL NADU
DR.M.G.R.MEDICAL UNIVERSITY
CHENNAI**

**EVALUATION OF PATIENTS WITH PENETRATING INJURY
TO ABDOMINAL ORGANS**

**at K.A.P.V Government Medical College & A.G.M.Government
Hospital, Trichy.**



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AIM OF STUDY

1. To evaluate the common patterns of injury.
2. To analyze the procedures to be done for penetrating injuries and the outcome.
3. To evaluate the effect of penetrating injury to abdominal organs, both intra and retroperitoneal, in relationship to various modes of injury.
4. To evaluate various associated injuries and their influence on the outcome
5. To evaluate the mode of presentation and the need for immediate resuscitation of victims of penetrating injury.
6. To evaluate the value of available investigating tools for the detection of injury to intra abdominal organs.
7. To evaluate common complications associated with penetrating injuries and their management.

EVALUATIONS OF THE PATIENT WITH PENETRATING INJURY

Mechanisms and Patterns of Injury

In general, blunt trauma is associated with multiple widely distributed injuries, whereas in penetrating wounds the damage is localized to the path of the bullet or knife (1). Evaluation of a patient with penetrating injury is made easier if the surgeon can focus attention on the wound made, the weapon or object which made it, and its effect of injuring the adjacent organs or neurovascular structures if involved.

The most important tool of evaluation in penetrating injury is proper clinical examination of the patient to determine the need for immediate laparotomy, or staged procedure after further evaluation or resuscitation. On physical examination, the most frequent physical signs of intra abdominal injuries after penetrating trauma are hypotension, abdominal distension, peritonitis, evisceration of omentum or small intestine or signs of visceral hemorrhage such as hematemesis, melena and hematuria.

A profoundly hypotensive patient who arrives in the casualty with a massive distended abdomen after a penetrating wound obviously has intra abdominal haemorrhage and needs urgent laparotomy. The same applies to patients who present with severe evisceration of omentum or small intestine after a slashing wound or gunshot injury. Even if subsequent findings reveal no bowel or omental injury, laparotomy is indicated in such cases.

In gunshot injuries, on inspection of the trunk and upper thighs any entrance or exit wounds are noted, especially in axilla, gluteal clefts and groin creases, as well as eviscerations of omentum, bowel and significant distension is noted. Signs of obvious peritonitis which include guarding, rigidity etc are indications of immediate exploratory laparotomy.

Many patients with low velocity gunshot wounds of the flanks or back, stab wounds of anterior aspect of abdomen or back etc, cannot be adequately evaluated by physical examination alone, since passage of knives or missiles through the abdominal Wall alone will cause some local swelling, tenderness and peritoneal signs, on occasion, which are misleadingly suggestive of true intra abdominal injuries.

DIAGNOSTIC PROCEDURES:

Radiological findings:

X-ray abdomen in erect posture is often helpful in diagnosing hollow viscus injury by the presence of air under the diaphragm, and other injuries due to the presence of retained missiles, a traumatic diaphragmatic hernia, and other associated injuries to chest such as hemo or pneumothorax. An **IVP & Ascending Urethrogram** can be performed to evaluate possible penetrating injuries to the kidneys, ureter, bladder or Urethra, in cases presenting with hematuria.

ULTRA SONOGRAM determines free fluid, blood, hematomas and visceral injury and post operative complication such as pelvic collection or abscess.

COMPUTED TOMOGRAPHY is mainly indicated for hollow viscus and retroperitoneal injuries and may aid other diagnostic modalities. CT is indicated primarily for hemodynamically stable patients who are candidates for nonoperative therapy. CT in patients with penetrating abdominal trauma has high sensitivity, specificity, Negative predictive value, and accuracy, but has lower Positive predictive value in determining the need for laparotomy. It follows that CT is an indispensable tool in predicting the need for laparotomy in these patients but still has room for improvement. (2) In a patient who has suffered either blunt or penetrating trauma because multi-organ injury is common in such patients, **Contrast-enhanced CT** is the primary imaging technique used to evaluate the upper and lower urinary tract for trauma.

RADIO NUCLEOTIDE SCANNING is not routinely used for early evaluation but HIDA scan can be used to document the location of biliary injury after repair of hepatic injuries.

COMBINED LAPAROSCOPIC EXPLORATION AND LAVAGE (LELA) in penetrating injuries shows a promising role to rule out mainly hollow viscus injuries. This technique could decrease the number of non-therapeutic laparotomies, length of stay and hospital costs without increasing the incidence of missed abdominal injuries (3). This has some limited use due to the cost and availability problems. One potential concern is carbon dioxide gas embolism through injuries of the hepatic veins. However, this complication can be eliminated with gasless laparoscopy.

EVALUATION OF PENETRATING WOUNDS FROM THE BACK:

The back wounds are a problem area. The posterior musculature on either side of the spine is several inches thick. Hence, small injuries to posterior aspect of ascending colon descending colon pancreas or kidneys would be missed and treatment delayed. DPL is not of value in such retroperitoneal injuries. The mainstay here is repeated Physical examination or C.T. for retroperitoneal injury, preferably contrast enhanced C.T.

Observation:

Often patients with peritoneal penetration by a knife or other sharp object will have no intra abdominal visceral or vascular injury at the time of exploration. Patients who are hemodynamically stable and show no signs of peritonitis or evisceration are evaluated by observation & serial physical examination. The development of either abdominal distension or hypotension, or signs of peritonitis during this period of observation confirms the diagnosis of intra abdominal visceral injury.

Wound exploration with or without diagnostic peritoneal lavage:

In patients with penetrating stab wounds between the nipples & costal margins, or in the flanks local wound exploration may create a pneumothorax or be very difficult due to muscle bulk. For this reason, infra umbilical or peri umbilical D.P.L. can be used on an empiric basis if the thought of possible peritoneal penetration is entertained.

In patients with stab wounds below the costal margins and inguinal ligament and between the anterior, axillary lines on both sides a stab wound exploration done under local anesthesia to document the penetration.

Diagnostic peritoneal lavage (DPL) remains the most sensitive test available for determining the presence of intra-abdominal injury. Diagnostic peritoneal lavage is performed through an infraumbilical incision. The linea alba is sharply incised. The catheter pierces the peritoneum with the aid of the trocar and is directed into the pelvis.

For stab wounds to the abdomen, its sensitivity for detecting intra-abdominal injury exceeds 95%. The results of DPL are considered to be grossly positive if more than 10 ml of free blood can be aspirated after insertion of the catheter. If less than 10 ml is withdrawn, a liter of normal saline is instilled and the patient is gently rocked from side to side and up and down. The effluent is withdrawn and sent to the laboratory for red blood cell count and amylase and alkaline phosphatase levels. A red blood cell count greater than 100,000/L is considered positive. The detection of bile, vegetable or fecal material, or the observation of effluent draining through a chest tube, a nasogastric tube, or a Foley catheter also constitutes a positive result.

20 White blood cell counts of the lavage effluent are not considered valid indicators of intraperitoneal injury. The main pit fall of DPL in penetrating trauma is its over sensitivity to the presence of retroperitoneal blood and a 4 to 5% incidence of false positive is noted which may lead to negative laparotomy.(1)

EXPLORATION.

All abdominal organs are systematically examined by visualization, palpation, or both. Missed injuries are a serious problem with often fatal results. In penetrating trauma missed injuries can occur if wound tracks are not followed their entire distance. A second common reason for missed injuries is failure to explore retroperitoneal structures such as the ascending and descending colons, the second and third portion of the duodenum, and ureters. Furthermore, injuries of the aorta or vena cava may be temporarily tamponade by overlying structures. If the retroperitoneum is opened and the injury overlooked, delayed massive hemorrhage may occur following abdominal closure. (1)

Mortality rate of penetrating thoracic and abdominal injuries is markedly lower than that of blunt injuries. Surgical operation is still important for those patients with penetrating injuries (4).

GUNSHOT WOUNDS:

Gunshot wounds present a special problem in that there is an incidence of 96 to 98% chance of visceral or vascular injury when a gun shot has penetrated the peritoneum. Hence the policy in major centre has been routine laparotomy for all penetrating gunshot wounds

Here again the mainstay of evaluation is repeated physical examination with or without DPL.

REVIEW OF LITERATURE

SURGICAL ANATOMY OF SOLID ORGANS OF ABDOMEN

Spleen:

Spleen is the largest lymphoid organ developed from mesenchymal differentiation along the border of the dorsal mesogastrium. It lies under the diaphragm on the left side of the abdomen closely in contact with 9th, 10th and 11th ribs. It lies along the long axis of 10th rib. It weighs about 100 to 150 Gms. Spleen is held in position by lienorenal ligament, gastrosplenic ligament and phrenico colic ligament. It is dull in colour, freely mobile, measures 1x3x5 inches, size and shape resembles roughly that of clenched fist.

Spleen is supplied by splenic artery which divide into upper and lower branches at the hilum and then into segmental arteries supplying the segments of spleen. Spleen is drained by splenic vein.

SPLENIC INJURIES

Clinical Manifestations:

Approximately one third of the patients with splenic injuries presents with modest hypotension. Signs of peritonitis in the left hypochondrium are present in 50 to 60 percent of patients, Kehr's sign or pain at the tip of the shoulder is present in less than 50 percent of the patients. Ballance sign or fixed dullness in the left upper quadrant with shifting of dullness in other areas of abdomen is rarely elicited.

Some patients presents with signs and symptoms of splenic rupture some time after original injury. This period is the latent period of baudet, reasons for this is the rupture of the larger subcapsular hematomas in delayed fashion.

MANAGEMENT AND COMPLICATIONS

Splenic injuries:

The abnormalities noted in plain x- ray of the abdomen in splenic injuries are

1. Elevation of left hemidiaphragm and immobilization of the diaphragm in fluoroscopy.
2. Enlargement of the splenic shadow.
3. Medial displacement of the gastric air shadow.
4. Widening of the space between the splenic flexure and the pre peritoneal fat pad.
5. Associated rib fractures if any.

The ultra sonogram can detect haemoperitoneum and splenic injuries: CT is more useful in clearly demonstrating the low density bands produced by defects in the parenchyma and sub capsular hematomas as low density lesions in the periphery. Significance of radionuclide imaging has declined after availability of modern CT. false-positive findings can occur in CT and radionuclide scan due to presence of congenital clefts. Arteriography is highly accurate in nothing disruption of parenchyma and extravasation of radio opaque dye into the peritoneal cavity.

TREATMENT:

The immunologic importance of the spleen was first recognized by Morris and Bullock in 1919, it is now generally accepted that it has at least four major activities.

1. Maintenance of elements of blood.
2. Clearing particulate matter from the blood stream.
3. Synthesis of antibody and related substances such as IgM, tuftsin, opsonins, and properdins
4. Acting as an important component of the immunosuppressor system and possibly as a reservoir of suppressor cells.

To maintain these functions spleen conservation procedures are now attempted.

Grading of the spleen injuries are shown in the Table-1

Non Operative Management:

It is indicated in

1. Those who had no period of hemodynamic instability.
2. Those without peritoneal findings at any time.
3. Those who did not require greater than two units of blood.

The major concerns about non operative management are

1. Risk of Transfusion associated hepatitis
2. Missed injury to other viscera

3. Delayed rupture of sub capsular hematoma.

Sequential radionuclide scans or CT examinations are required to monitor complete healing.

Spleen Conservation Procedures:

This may be in the form of

1. Topical application of haemostatic agents.
2. Splenorrhaphy with or without Topical agents especially in pediatric age group.
3. Hemi splenectomy or partial splenectomy.

TOPICAL AGENTS:

Topical haemostatic agents like surgicel (oxidized regenerated cellulose) or Avian (microfibrillar collagen hemostat) or gel foam can be applied over small Capsular tears or avulsions with moderate bleeding under a dry laparotomy pad and pressure maintained for 5 to 10 mts, alternatively fibrin glue can also be used.

SPLENORRHAPHY:

It is indicated in

1. Stabled patients with few associated intra abdominal injuries especially in children.
2. Grade 1-4 magnitude of injuries to spleen.
3. It is contraindicated in.
 - i. Patients with splenic injury who have been previously noted to require splenectomy

- ii. Patients with diseased spleen like topical splenomegaly.

Parenchymal fractures or lacerations are best repaired with horizontal mattress sutures using 0- chromic catgut. The capsular tearing may be minimized by placing the sutures over a viable pedicle of omentum or Teflon pledgets. When there are several large parenchymal lacerations, polyglycolic acid mesh (hair net) or a through and through horizontal mattress sutures using needle may be applied.

PARTIAL SPLENECTOMY:

It is indicated when there is avulsion of superior or inferior pole of the spleen or injury to the splenic hilar vessels. The segmental branch to the devascularised pole should be ligated first. Then the non viable portion can be removed from the viable portion by using electro-cautery.

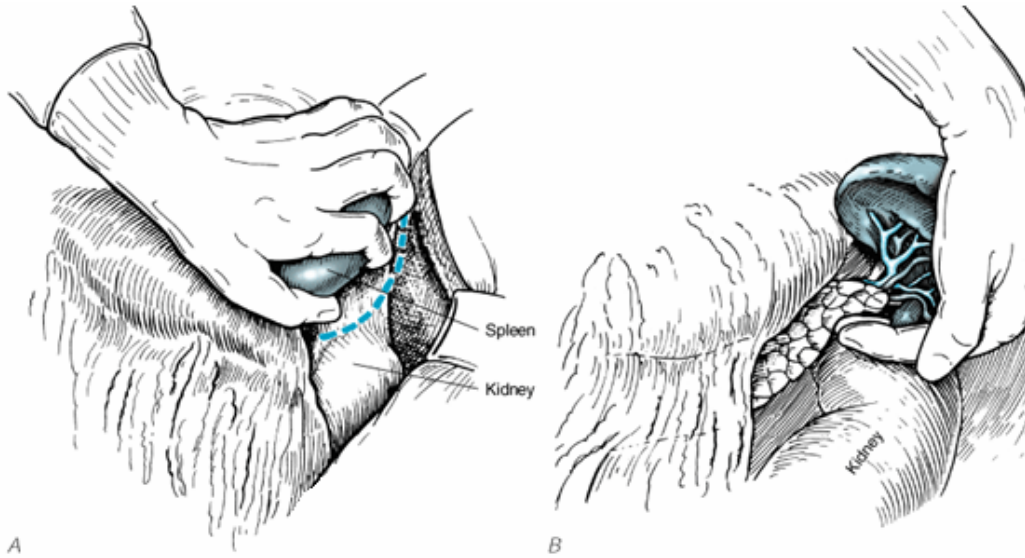
Splenectomy:

It is indicated in

1. Hypotensive patients
2. Multiple associated intra abdominal injuries.
3. shattered or avulsed spleen
4. failure of splenorrhaphy

When mobilizing the spleen for repair or removal, the peritoneum and endoabdominal fascia behind the spleen must be incised. The incision should be made about 1 cm lateral to the reflection of the peritoneum onto the spleen. Traction must not be applied to the spleen or the peritoneal reflection will tear,

which often results in splenectomy. Instead, the peritoneal reflection is exposed by applying posterior pressure and rotating the spleen medially



The plane between the pancreas and left kidney is then developed .When completed, the spleen should be able to reach the level of the abdominal incision.

COMPLICATIONS:

The common complications are

1. Lower lobe atelectasis
2. Left pleural effusion
3. Seroma in the left upper quadrant and
4. Left subphrenic abscess
5. Overwhelming post-splenectomy sepsis occurs in fewer than 2.5% of patients.

This results from encapsulated micro organisms such as pneumococcus, meningococcus, and haemophilus. The incidence is greatest within 2 yrs after splenectomy.

RESULTS AND MORTALITY:

In patients with poly trauma undergoing splenectomy the morbidity is 20%. The mortality following splenectomy varies depending on the mechanism of injury. It ranges from 10-20% in recent series. The commonest cause of mortality is due to associated injuries like head injury etc.

Liver:

Liver lies in the right upper quadrant of the abdomen beneath the diaphragm and connected to the digestive tract via the portal vein and biliary drainage system is the largest intra abdominal organ weighing about 1500 gm. The superior surface confined to the under surface of the diaphragm. The inferior surface is in contact with duodenum, colon, kidney, adrenal, oesophagus and stomach. In adult the normal liver extends upto right 5th intercostals space in midclavicular line. French system (couinaud) divides liver into 8 surgical lobes according to blood supply. Right and left lobes are divided along the line passing through the medial aspect of the gall bladder bed and IVC. Blood supply is from the hepatic portal system, supplying 25% and 75% respectively but the oxygen is supplied mainly by hepatic arterial blood. Liver is drained by right, left and middle hepatic veins. Bile synthesized and excreted in the liver is carried in the right and left hepatic ducts which join to form common hepatic duct.

The ligaments attached to the liver are right and left triangular ligament, coronary ligament, falciform ligament and lesser omentum. Pringle's maneuver is the temporary application of vascular clamp to the free margin of lesser omentum to occlude the hepatic artery, common bile duct and portal vein which are present in the free border of lesser omentum. Clamp may be applied for 20 mts to 1 hr. it is indicated in arresting major bleeding from hepatic and perihepatic injury. Topical cooling and IV methyl prednisolone 30-40 mg/kg have been found to protect the hepatocytes during clamping.

LIVER INJURIES:

Hepatic trauma is suspected in a patient with the location of trauma in the right upper quadrant, profound hypotension temporarily responding to infusion of blood and fluids and marked abdominal distension

Plain x-ray abdomen will show altered liver border, haemoperitoneum, and associated rib fractures if present. Abdominal paracentesis may reveal haemoperitoneum. DPL is diagnostic of minimal haemoperitoneum although it is not specific for liver injury. CT is indicated in stable patients with multiple injuries. The main indication for arteriography in hepatic injuries is in patients with continued bleeding in the early postoperative period and in late haemobilia. Radionucleotide scan is not routinely done .Hepatic imino diacetic acid (HIDA) scan has been successfully utilized to document the location of biliary fistula after hepatic injuries. Grading of the hepatic injuries is shown in the table-(2).

TREATMENT

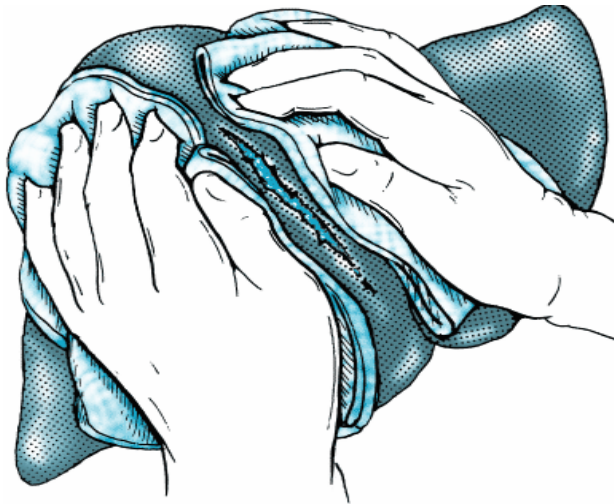
SIMPLE TECHNIQUES OF REPAIR:

1. DRAINAGE OF NON BLEEDING INJURES:

Rarely performed now a days because any avulsed biliary ducts or bleeding small vessels can be directly visualized and suture ligated.

2. COMPRESSION:

Small cracks in the capsule or superficial lacerations can be treated by compression for 5 to 10 minutes.



3. TOPICAL AGENTS:

Topical agents can be used to stop bleeding. The topical agents used are surgical microfibrillar collagen and gel foam. Fibrin glue is a non autologous highly concentrated human fibrinogen and clotting factors to which aprotinin, a fibrinolysis inhibitor is added. Fibrin glue can be used. This

remains in situ for 2 to 4 weeks and lacks significant tissue reactivity. Drainage is not necessary except for any obvious bile leak.

4. SUTURE HEPATORRHAPHY:

This is done in class – II parenchymal lacerations, which account for more than 50% of all hepatic injuries, which was not controlled with other measures. Classically horizontal mattress sutures with 0- chromic catgut often placed with blunt needle is used. A continuous suture of 0- chromic catgut can also be used. With these measure most of the bleeding stops except when a severe coagulopathy is present.

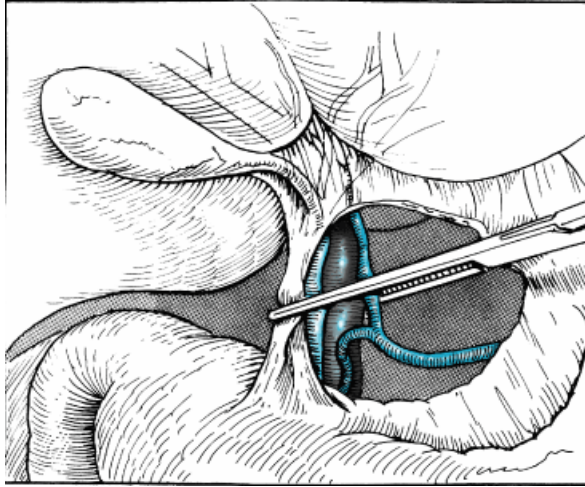
ADVANCED TECHNIQUES OF REPAIR:

Class III and class IV injuries of trauma requires advanced Techniques

1. EXTENSIVE HEPATORRHAPHY:

It refers to the use of multiple deep horizontal mattress sutures in the parenchyma its use has diminished in the last 5 to 10 years because bleeding from hepatic artery, portal vein and hepatic veins were often not controlled and intrahepatic hematomas and abscesses were occurring. This also results in extensive hepatic necrosis which results in postoperative fever, and hemobilia can also result.

2. HEPATOTOMY WITH SELECTIVE VASCULAR LIGATION:



The basic principle of hepatotomy is to do whatever is necessary to obtain the exposure of the deeply placed bleeding vessel with pringle maneuver in place. The edges are retracted and the base inspected for bleeding vessels, if not visualized the surgeon must use finger fracture or some blunt technique to divide the liver parenchyma in line with the laceration and the bleeding vessel identified and ligated. Failure in arrest of bleeding with these measures strongly suggests injury to retro hepatic vena cava or major hepatic veins.

2. METHODS OF TAMPONADE

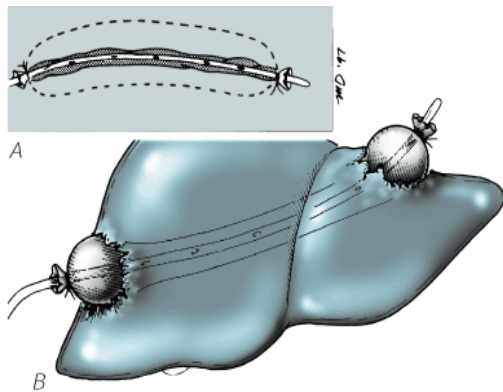
1. OMENTAL PACK:

Omentum is placed into deep lobar lacerations to control haemorrhage. The omentum will create tamponade of small bleeding vessels, and aid in the absorption of a modest amount of necrotic hepatic tissue and clot which results in decreased incidence of postoperative perihepatic abscesses. Omentum is mobilized from the transverse colon and the

vascularised pedicle is loosely placed over the liver laceration or hepatotomy site and loosely fixed with chromic sutures.

2. TRANS HEPATIC BALLOON TAMPONADE

Used to tamponade hemorrhage from transhepatic penetrating injuries.



A. Intrahepatic balloon

B. Intrahepatic balloon in situ

3. RESECTIONAL DEBRIDEMENT WITH SELECTIVE VASCULAR LIGATION:

Indicated whenever there is loose friable and partially devascularised tissue on the edge of this liver. It is preferred than hepatic resection which frequently sacrifice large amounts of normal hepatic tissue. It is done by finger fracture technique just outside the area of injury and the feeding vessels are clipped are or ligated when they are still intact.

4. RESECTION:

Resection refers to anatomic removal of a hepatic segment or a lobe. The only indications at this time are

- i. When there has been total disruption of a segment or a lobe when it is the only technique that will control life threatening haemorrhage.
- ii. When the extent of haemorrhage precludes the use of perihepatic packing.

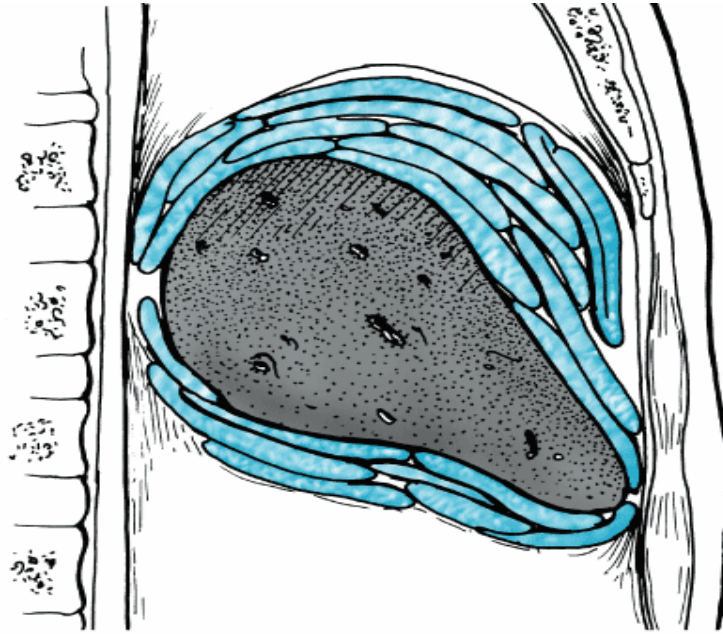
5. SELECTIVE HEPATIC ARTERY LIGATION:

This is done based on the fact that higher O₂ saturation in the portal veins of the humans, absence of portal bacteraemia in humans and extensive collateral arterial flow. This technique is primarily indicated when selective clamping of the extralobar hepatic artery causes association of arterial bleeding and when the injured vessel cannot be visualized inside the liver. If right hepatic artery is ligated it is safe to perform cholecystectomy.

6. PERIHEPATIC PACKING:

This technique involves the insertion of laparotomy pads or roller gauze around the injured liver, not into the lacerations. It is indicated in

1. Lack of facilities, blood or experience.
2. Transfusion induced coagulopathy
3. Continued bleeding after routine measures and the patient is not fit for resection.
4. Bilobar injury
5. Subcapsular hematoma
6. Need to terminate operation because of profound hypothermia



Pack removal is safe when coagulopathies, hypothermia, are corrected.

This can be done as soon as 12 hours after packing.

The complications are

Compression of the supracaval vena cava with secondary oliguric renal failure

Increased incidence of perihepatic sepsis

Rebleeding which is common.

7. DRAINAGE:

Minor or modest hepatic injuries in which satisfactory haemostasis obtained and no obvious biliary leak is present do not require drainage. Closed suction drains are indicated in major hepatic lacerations requiring hepatotomy or resectional debridement, expecting persistent oozing or biliary leak.

CURRENT APPROACH TO HEPATIC INJURIES:

1. Current Approach to Hepatic injuries are Extension of pringle time (60 mts)
2. Hepatotomy with selective vascular ligation in preference to crushing mattress sutures.
3. Resectional debridement in preference to major resection.
4. Omental packs in deep cracks or hepatotomy sites.
5. Perihepatic laparotomy pad packing for oozing
6. Closed suction drains.

COMPLICATIONS:

1. Bleeding in the immediate post operative period is a common complication because liver receives 25 to 30% of total cardiac output as well as liver is the major site of synthesis of all coagulation factors.
2. Haemobilia manifesting as upper G I bleeding. Emergency arteriogram with selective embolization of the offending hepatic artery is indicated.
3. Intra abdominal abscess.

Patients at the highest risk of developing abscess are

- i. Those with continued haemorrhage
- ii. When concomitant colon injury was also present
- iii. When open drainage is established.

Percutaneous drainage is attempted through the flank first: when it is not successful reoperation should be performed.

4. Biliary fistula:

It is common in patients who have had major hepatic resection, resectional debridement or deep hepatotomy. In the absence of distal obstruction almost all biliary fistulae close within 6 weeks. If major destruction of a large intra hepatic duct is present, resection of the involved lobe or an intrahepatic roux-en-y hepaticojejunostomy should be considered.

5. Hyperpyrexia:

Major etiology remains unclear. Probable etiology is absorption of devitalized parenchyma. It usually resolves in 3 to 5 days after operation.

Pancreas:

Pancreas occupies a retroperitoneal position in the abdomen lying posterior to the stomach and lesser omentum. Pancreas was originally thought to act as a cushion for the stomach. It is a composite gland whose exocrine acini discharge their secretions into the duodenum to assist in digestion. The islets of langerhans, a group of endocrine cells in the pancreas plays a special role in the metabolism of carbohydrates. The gland is retort shaped, length varying from 10 to 20 cm, weighing about 75 to 125 gms, distinct yellow, tan or pink coloured, soft with finely lobulated surface. Pancreatic duct is a continuous tube leading from the tail to the head draining the upper part of head, neck, body and tail. Accessory pancreatic duct drains the lower part of head and uncinata process

The gland is divided into 1. Head, molded into the c. shaped concavity of the duodenum. 2 Neck. 3. Body and 4.Tail.

It is covered anteriorly by peritoneum with attachment of transverse mesocolon. Posteriorly it lies in close proximity to IVC, right renal vein, aorta at the level of 1st lumbar vertebra, superior mesenteric vessels, and splenic vein.

Pancreas is supplied by superior and inferior pancreaticoduodenal vessels and branches from splenic and right gastroepiploic arteries. Venous drainage is by veins following arteries into the portal vein.

The pancreas extends across the upper abdomen and for this reason direct stabs result in variety of injuries which range from simple capsular contusions to ductal transections over the spine to major lacerations in the head or tail. Difficulty in diagnosis of injuries to pancreas is due to

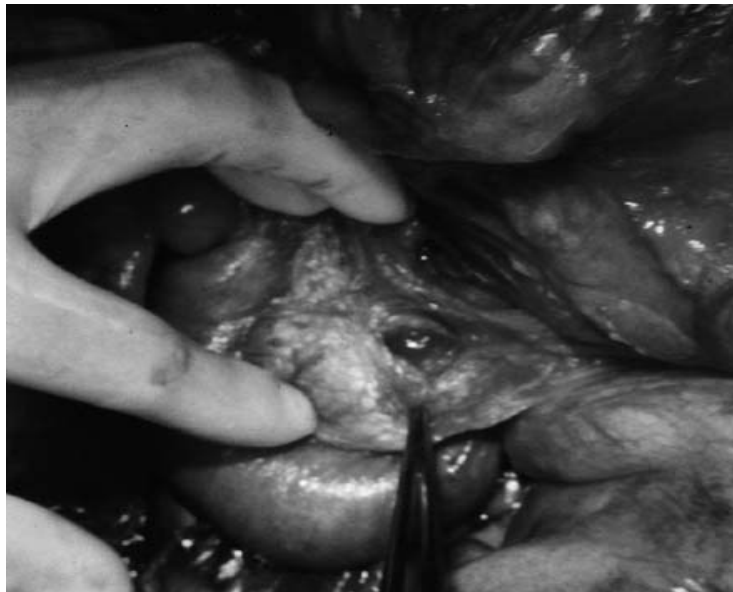
1. Minimal clinical signs and symptoms initially
2. Retroperitoneal location of the organ
3. Tamponading effect of the retroperitoneum
4. DPL will not be helpful.

PANCREATIC INJURIES:

Plain X-ray abdomen is usually not contributory. C.T. scan is an excellent technique because pancreas is a retroperitoneal structure. It is possible to distinguish between the mild traumatic pancreatitis involving diffuse swelling of the gland and transection of the pancreas. Thickening of the left anterior renal fascia has been noted in many patients. 16 and 64-Multi

Detector CT have low sensitivity for detecting pancreatic injury and duct injury, while exhibiting a high specificity for pancreatic duct injury. Their use as decision-making tools for the nonoperative management of pancreatic injury are, therefore, limited.

ERCP done by experienced person may be a useful diagnostic modality if CT is equivocal or not available. It is rapidly performed and clearly documents the presence and location of a transected pancreatic duct.



TREATMENT

Control of active haemorrhage is necessary before evaluation of pancreas. The choice of surgery depends on

1. Time elapsed since injury
2. Hemodynamic status.
3. Presence and absence of ductal injury

4. Presence and absence of concomitant duodenal injuries.

The anterior aspect of body and tail is easily visualized by division of the gastro colic omentum. The posterior aspect of the body is visualized by dividing the retro peritoneum inferior to the pancreas.

The various surgical procedures are

1. Drainage:

Drainage is routinely performed procedure for all pancreatic injuries. Now there has been a tendency not to drain the minor injuries as post operative pancreatic fistulae are extremely rare.

2. Pancreatorrhaphy with or without omental plug:

Overseeing the edges of the pancreatic laceration has some appeal for control of hemorrhage. Omentum will absorb small pancreatic leak & eliminates the problem of necrosis.

For patients with ductal transection in the neck, body or tail of the pancreas the treatment options are

1. Distal pancreatectomy
2. Roux-en-Y distal pancreatojejunostomy

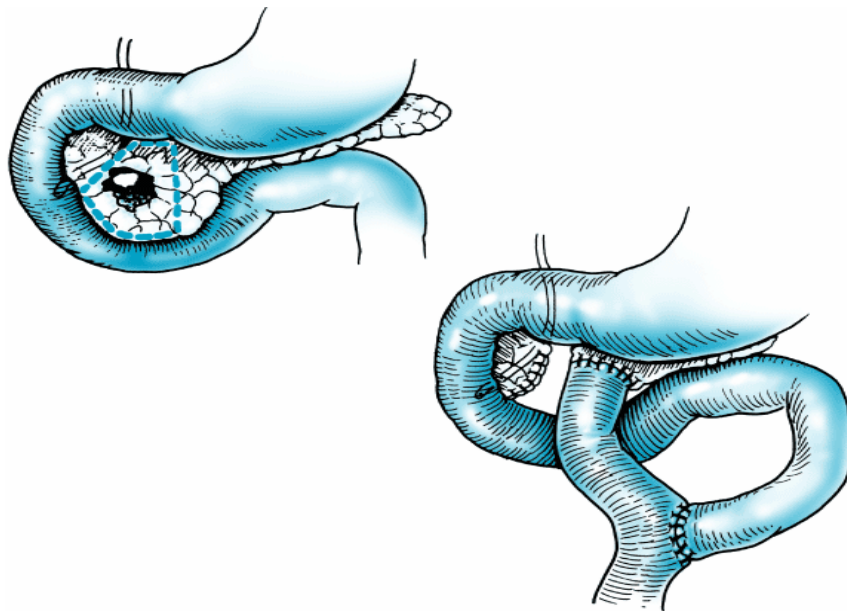
The obvious sign of an injury to pancreatic duct is continuous flow of clear pancreatic juice in the area of laceration or perforation and presence of extensive fat necrosis. Intra operative pancreatography can delineate the duct.

3. Distal Pancreatectomy:

It is indicated in transection of pancreatic duct that occur to the left of the mesenteric vessels. The extent of resection in these patients is usually 50 to 60% of pancreas. It is better to do splenectomy by dividing splenic vessels 1 to 2 cm proximal to the pancreatic ductal transection. The distal end of the remaining pancreas is closed by fish mouthing and suturing of the anterior and posterior lips. Spleen can be preserved in patients who are hemodynamically stable.

4. Roux-en-Y Distal Pancreatojejunostomy:

It is indicated in patients in whom ductal transection is to the right of the mesenteric vessels. Distal pancreas is preserved because the post operative left subphrenic abscesses will be significant and hyper glycemia will result in certain percentage of patients who undergo pancreatic resection.



In patients with ductal transection in the head, the treatment options are:

1. Roux en T distal pancreatico jejunostomy
2. Anterior Roux en Y pancreatico jejunostomy
3. Resection

5. Anterior Roux-en-Y pancreatico jejunostomy:

It is indicated in rare occasion of injury in the head of the pancreas that completely transect the pancreatic duct but leave the parenchyma intact posterior to the duct in these patients roux-en-Y limb can be sewn in as end to side fashion. It is a technically demanding surgery and post operative leaks are common.

6. Resection:

Resection of the head of the pancreas is indicated in,

Patients with duodenal injuries.

Total maceration of head of the pancreas

Multiple perforations in the head of the pancreas with complex duodenal injuries.

Destruction of ampulla of Vater.

COMPLICATIONS:

The complications are:

Lesser sac or left subphrenic abscess.

Pancreatic fistula

Pseudo cysts of pancreas

The mortality ranges from 17 to 19%.

DUODENAL INJURIES

Duodenal injuries are uncommon and are found in only 3.7% of all laparotomies for trauma. Primary repair of duodenorrhaphy is successful in the majority of duodenal wounds. However, duodenal trauma can be complex and the management is difficult, especially when the diagnosis is delayed, when massive injury to the pancreatic-duodenal-biliary complex occurs from penetrating trauma.

ANATOMY

The anatomy of the duodenum is unique and complex because of its close relationship with vital structures. The duodenum is 12 inches (24 to 26cm) long-hence its name. It is a retroperitoneal organ except for the anterior half of the circumference of its first portion it extends from the pylorus to the ligament of Treitz and is molded around the head of the pancreas in C-shaped fashion. The duodenum is divided into four parts Superior (first), descending (second), horizontal (third) and ascending (fourth). The first or superior part is 5cm long, the most mobile, extending from the pyloric vein of Mayo to the common bile duct superiorly and the gastroduodenal artery inferiorly.

The second or descending part is 8 to 10cm long and ends at the major duodenal papilla (ampulla of Vater), located over its posteromedial wall. An accessory pancreatic duct may open 2 cm proximally into the minor duodenal papilla. The third or horizontal part is about 10cm long and extends from the

ampulla of Vater to the superior mesenteric vessels. The ascending - fourth part is 2.5cm long and ends at the ligament of Treitz.

The duodenum is situated entirely above the level of the umbilicus. The duodenum shares its blood supply with the head of the pancreas, derived from the celiac and superior mesenteric vessels. The gastro duodenal artery, originating from the hepatic artery, gives off the inferior anterior and posterior pancreatico duodenal arteries gives branches to the duodenum and head of the pancreas.

Further blood supply is derived from the right gastric artery, the gastro epiploic artery, the supraduodenal artery of Willkie, and the retro duodenal artery. Anatomic variations involve the gastro duodenal artery, which originates from the left hepatic artery in 11%, right hepatic artery in 7% hepatic trunk in 3.5% or directly from the celiac or superior mesenteric arteries. The common bile duct enters the second portion of the duodenum through its posteromedial wall. In 85% of individuals, both the common bile duct and the pancreatic duct enter through a common channel into the ampulla of Vater. However in 10% of individuals, both ducts enter the duodenum separately into two ampullae and in the remaining 5%, both ducts enter the duodenum through separate channels but into the same ampulla

INCIDENCE

Lying deep within the abdomen, the duodenum is well protected in the retroperitoneal space. Owing to the increased incidence of automobile accidents and the greater devastation of the modern weapons being used in

violent assaults, duodenal injuries are seen with much greater frequency than 40 years ago. Penetrating trauma is the most common cause of duodenal injuries. The reported incidence of duodenal injury ranged from 3.7% to 5% in the literature. Asensio and associates reported 17 duodenal injuries in 402 cases of abdominal trauma (4.2%) during the Korean War. In 1968, Morton and Jordan reported an incidence of 5% among 280 patients with abdominal trauma.

The second portion of the duodenum is injured most commonly, in 35% of the cases. The third and fourth portions are each injured in approximately 15% of the cases, and the first portion is wounded in only 10% multiple injuries are seen in the remaining.

DIAGNOSIS

Duodenal injuries from trauma continue to pose a diagnostic challenge. The organ's retroperitoneal location may produce minimal and vague symptoms such as abdominal, back, or flank pain radiating to the neck or testicles has also been reported. The key to diagnosis is a high index of suspicion based on a consideration of the injury mechanism.

Radiologic studies may be helpful in the diagnosis. Plain films of the abdomen may show retroperitoneal air, free intraperitoneal air, or air in the biliary tree. Other signs such as obliteration of the psoas muscle shadow and scoliosis of the lumbar vertebrae should trigger suspicion of duodenal trauma. In the absence of such signs and in the face of a high degree of suspicion, air can be injected through a nasogastric tube just before the abdominal film is

taken, in order to enhance the demonstration of retroperitoneal air. If this is not helpful, an upper gastrointestinal series with water soluble material is obtained. A negative study may be repeated with thin barium.

Exploratory laparotomy remain the diagnostic test in a high degree of suspicion of duodenal injury continues in the face of absent or equivocal radiographic signs.

In patients with penetrating trauma, the diagnosis of duodenal injury is usually made at laparotomy. The majority of trauma centers practice a policy of mandatory exploration for penetrating gunshot wounds. In the case of stab wounds, most favor selective exploration. In either event, most of the patients with complex penetrating duodenal injuries have an early exploratory laparotomy, and the duodenum is evaluated for injury.

INTRAOPERATIVE ASSESSMENT

It is important to establish a set routine for exploration of the retro peritoneum, because subtle injuries may easily be missed. After control of hemorrhage, special attention is directed to detect bile staining of the retro peritoneum, small bubbles of entrapped air in the peri duodenal tissues, and small periduodenal hematomas. These may be the earliest clues suggestive of a lacerated duodenum.

The next step is to Kocherise the entire duodenum. This facilitates inspection of the first, second, and a portion of the third parts of the organ. The Cattell and Brassch maneuver consists of mobilization of the hepatic flexure of the colon, sharp dissection of the small bowel attachment from the

ligament of Treitz to the right lower quadrant, and cephalad displacement of the small bowel. This brings the third portion of the duodenum into view and also facilitates an assessment of the integrity of the pancreas. The fourth portion of the duodenum may be evaluated by mobilizing the ligament of Treitz.

Optimal management of duodenal injuries requires a complete assessment for an associated injury to the pancreas as well as the bile duct and the ampulla. Therefore, an injury to the duodenum in the second portion must prompt an evaluation of these structures. This can be accomplished by a careful visualization of the pancreatic head for hematoma or laceration. Bile extravasation with a laceration in the area of the head of the pancreas may suggest an injury to the intrapancreatic portion of the bile duct or the ampulla.

DEFINITION OF COMPLEX INJURIES

Severe duodenal injury, according to Snyder et al, is associated with the following factors: (1) missile or blunt injury: (2) injury of the first or second portion of the duodenum: (3) an injury-operation interval of greater than 24 hours: and (4) adjacent common bile duct injury. An algorithm for management of duodenal injury is seen in table (5).

TREATMENT

In the hemodynamically unstable patient, the optimal treatment is an abbreviated laparotomy with control of hemorrhage, rapid closure of gastrointestinal lacerations by suture or stapling, provisional closure of the skin, and intensive care unit resuscitation. Restoration of the continuity of the gastrointestinal tract is accomplished at a second operation, when the

patient's hypothermia, acidosis and coagulopathy have been corrected and resuscitation parameters have been optimized.

The incident of complex duodenal injuries is fortunately not very high. The vast majority of duodenal injuries may be managed by simple procedures such as debridement and primary repair of resection and anastomosis. This is especially true of penetrating injuries, for which early operative treatment is the rule rather than the exception.

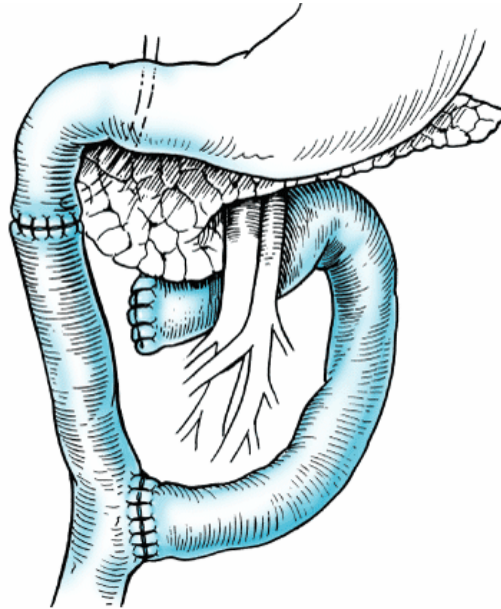
1. TUBE DECOMPRESSION

Originally introduced by Stone, "triple ostomy of a gastrostomy duodenostomy and jejunostomy was recommended by stone and Fabian. The tube decompression can be achieved either antegrade, proximal to the injury site, or retrograde, via a jejunostomy. A feeding jejunostomy distally in the jejunum is, however, used in patients with extensive abdominal injury (Abdominal Trauma Index 25)

2. Resection and End to End Anastomosis

If the duodenal injury has caused a large defect in the wall (longer than 3 cm in diameter), primary closure of the defect may narrow the lumen of the bowel or result in undue tension and subsequent suture line breakdown. Segmental resection and primary end to end duodeno-duodenostomy are usually feasible when dealing with injuries to the first, third and fourth portions of the duodenum. This may be technically difficult when dealing with injury to the second portion because the ampulla of Vater and the intimate relationship

of the duodenum to the pancreas may limit adequate mobilization. In such patients a serosal patch or duodeno jejunostomy can be done.



Roux-en-y duodeno jejunostomy is used to treat duodenal injuries between the papilla of Vater and superior mesenteric vessel when tissue loss precludes primary repair.

3. Pedicle Mucosal Graft:

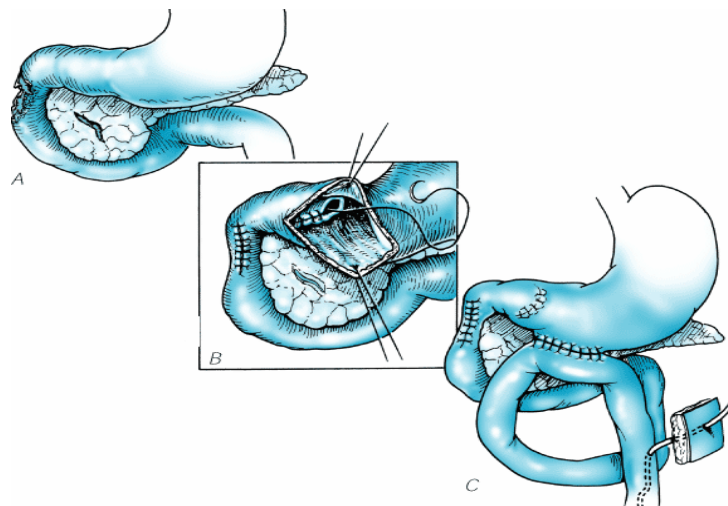
An alternative to the use of a serosal patch for large duodenal defects is the use of pedicled mucosal graft. Such grafts may be taken from the jejunum or the stomach.

4. Duodenal Exclusion Procedures

More complex procedures such as duodenal diverticulization or pyloric exclusion should be considered for severe duodenal injuries. The main

purpose of such procedures is to exclude the duodenal repair from gastric secretions and allow time for adequate healing of the duodenal repair.

The operation consists of suture closure of the duodenal injury, gastric antrectomy with end to side gastrojejunostomy, tube duodenostomy and generous drainage in the region of the duodenal repair. The main problem with duodenal diverticulization is that it is a time consuming operation, ill advised in a hemodynamically unstable patient or when multiple injuries are present. Furthermore, it requires resection of an uninjured antrum.



A superior variant of excluding the duodenal suture line and diverting gastric contents is pyloric exclusion. After primary repair of the duodenal wound is achieved, a gastrotomy incision is made on the greater curvature of the antrum over its most dependent portion, at a site suitable for a gastrojejunostomy. The pyloric ring is identified and grasped from inside the gastrotomy. It is then closed with a running suture of nonabsorbable material such as polypropylene. Alternatively, a staple line may be placed across the

pylorus. A gastrojejunostomy is performed at the gastrotomy site. Irrespective of the method used to close the pylorus, care must be taken to avoid closure of the prepyloric antrum, as this causes increased gastrin secretion and elevated gastric acid output.

Minor grades of duodenal and pancreatic injuries may be treated by simple techniques of debridement and drainage of the pancreatic injury. Other combinations of injuries involving severe grades of either duodenal or pancreatic trauma may occur. These injuries require more complex procedures such as pyloric exclusion and pancreatico-duodenectomy.

1. Primary repair and drainage are used for simple duodenal injuries with nonductal pancreatic injury grades 1 and 2.
2. More extensive duodenal injuries combined with pancreatic injuries not involving that duct to the right of Superior mesenteric vessels are best treated with repair or resection of both organs as indicated, pyloric exclusion, gastrojejunostomy and drainage.
3. Lacerations in the head of the pancreas with ductal involvement, devascularizing lesions of the duodenum, or duodenal lacerations with destruction of the ampulla and distal common duct [grade V injuries of these structures in any combination] are best treated by a one stage or two stage pancreatico-duodenectomy as discussed above.

MORBIDITY AND MORTALITY

The most serious complication following the treatment of duodenal injury is the development of a duodenal fistula from suture line dehiscence. Other complications reported with duodenal trauma (may or may not be directly related to the duodenal injury itself) include (1) intra abdominal abscess, (2) pancreatitis, (3) Duodenal obstruction and (4) Bile duct fistula.

The management of a duodenal fistula consists of extensive drainage, nutritional support by intravenous hyper alimentation or preferably by external feeding through a jejunostomy, drainage of all associated intra – abdominal abscesses, and the antibiotic therapy. If the patient has undergone duodenal exclusion abdominal diverticulization or pyloric exclusion) at the original operation, such a fistula usual closes with conservative management. If, however a duodenal exclusion has not been performed and a high output fistula persists beyond 3 weeks despite adequate drainage and nutritional support, duodenal exclusion at reexploration should be considered.

The overall mortality rate of duodenal injuries continues to be significant. This mortality, however, is related more to the extent of associated vascular injuries or injury to the adjacent head of the pancreas.

SUMMARY

Duodenal trauma, with diagnosis and prompt treatment, can be managed effectively by simple surgical techniques. Severe duodenal injuries and those associated with major destruction of adjacent structures. The pancreatobiliary complex or abdominal vessels require a more thoughtful strategy that incorporates a careful consideration of the physiologic stability of the patient and the extent of local destruction.

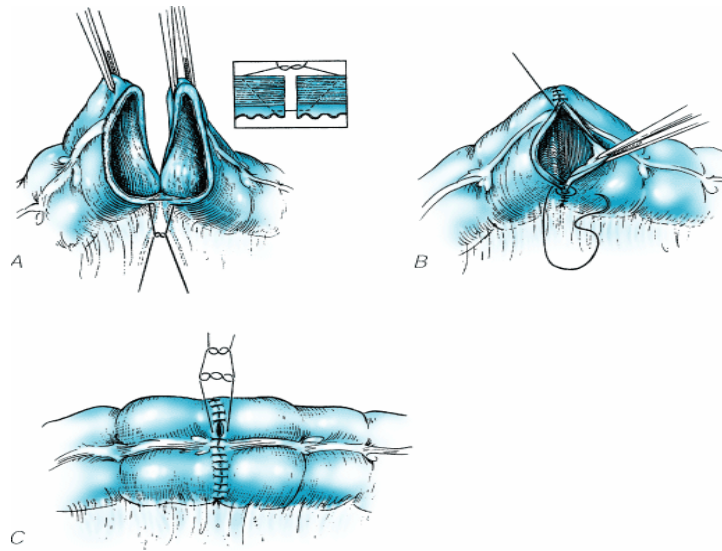
COLON:

A simple repair or diversion procedure is needed. A single-layer running suture technique is used for gastrointestinal repairs and anastomosis whenever possible.

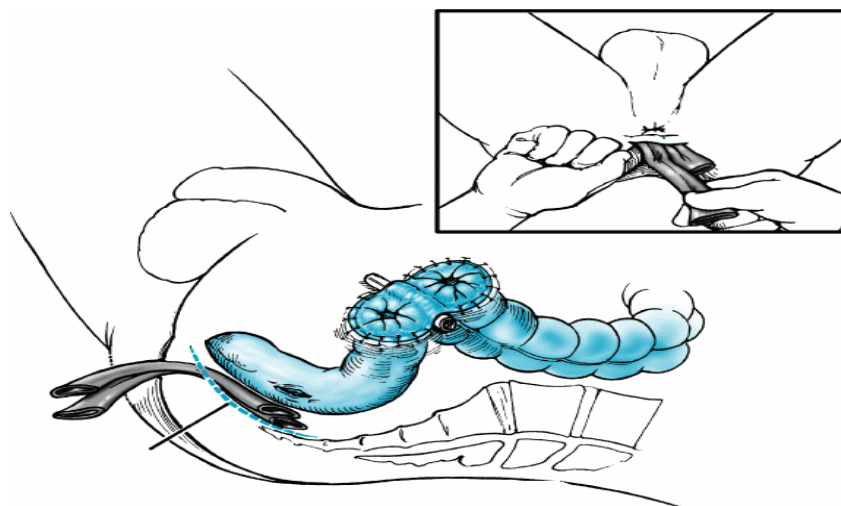
A. the suture line is started at the mesenteric border. The stitches are placed 3 to 4 mm from the edge of the bowel and include all layers except the mucosa

B. To ensure a secure suture line on the mesenteric border, both limbs of the suture are brought out from the mesenteric border.

C. Each stitch is advanced 3 to 4 mm: the suture is tied near the antimesenteric border

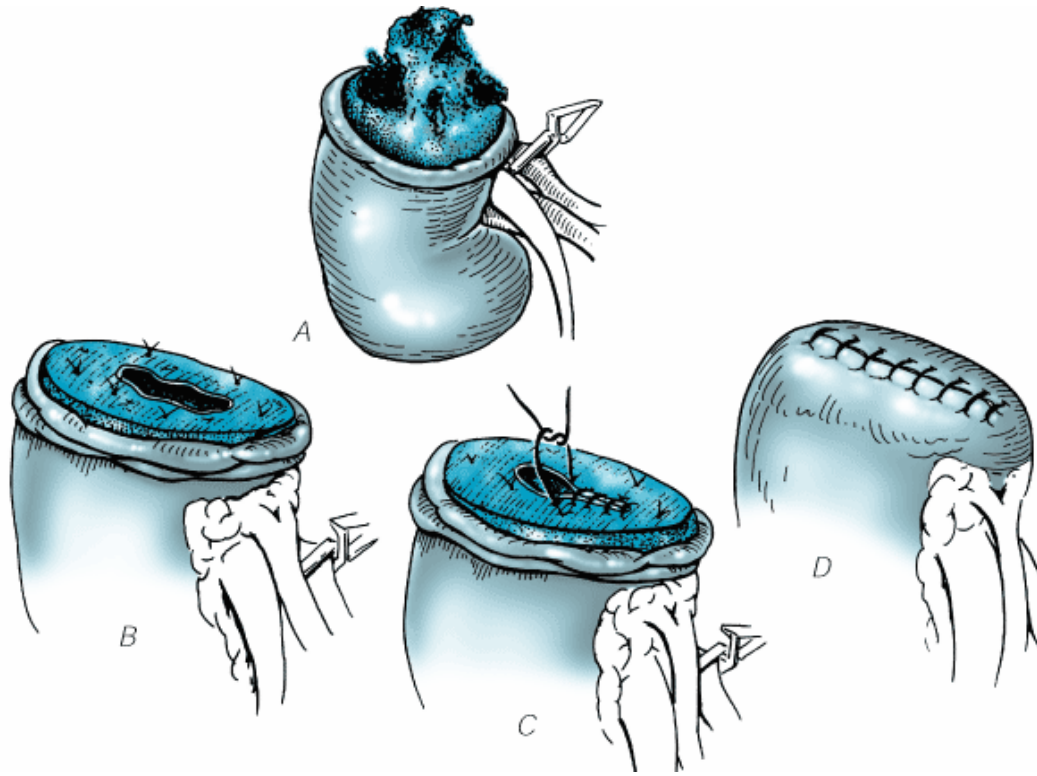


A properly constructed loop colostomy will completely divert the fecal stream. The essential elements include maintaining the spur of the colostomy above the level of the skin, a longitudinal colostomy, and immediate maturation. The drains are placed through a retro anal incision. The fascia of Waldeyer is often very tough and may need to be incised. The drains are then advanced to the level of the rectal injury.



RENAL INJURIES:

Renal parenchymal injuries can sometimes be repaired by partial nephrectomy. The need for repair depends on the patient's condition and the status of the other kidney.



A. Intermittent vascular control permits precise control of bleeding vessels. B. The renal capsule is carefully preserved. C. and D. The collecting system is closed with absorbable suture, and the remaining capsule is closed over the collecting system repair

MATERIALS & METHODS

In my study I have included fifty patients who presented to the casualty as emergencies with penetrating wounds of abdominal organs of various types and sites of wounds.

The time interval between sustaining the injury and that of admission and the time between admission and operation has been noted and their significance studied.

The various weapons, modes of injury, the site of penetration, the organs injured, and the methodology of surgical treatment have been studied.

The Hemodynamic status of the patient at the time of presentation and the resuscitatory methods employed has been discussed.

The associated injuries, their role in influencing treatment and the various post operative events and complications have been studied.

Overall evaluation of the patients with penetrating injury and its role in the outcome has been studied.

Plain X- ray of the abdomen in erect posture was taken in most of the cases except in those in a very bad condition. Radiography of other parts was also taken to find out associated injuries, when present.

Wound exploration under local anesthesia was done for almost all the patients, and entry into peritoneal cavity was taken as the main criterion for laparotomy.

Routine Biochemical testing for Urea, sugar and HB% estimation was done for all the patients prior to surgery.

Pre operative resuscitation of all the patients, with I.V. fluids, parenteral pre operative antibiotics, and blood transfusion in selected cases were given. Post operative nasogastric aspiration, daily observation of vital signs, intake and output monitoring, wound care, antibiotics and analgesics were prescribed. Post operative complications were specifically looked for and recorded, and were appropriately treated.

OBSERVATION AND CORRELATION

Abdominal injuries are a common place occurrence and injury to abdomen due to penetrating wounds forms a sizeable part of emergency admission in our hospital. Our hospital being situated in a rural and semi urban area, injuries due to bull gore and stab injuries due to knife, and agricultural accidents due to tractor plough etc., form the main forms of injury in my series.

Gunshot injuries to the abdomen are rare in this part of the country.

There was no gunshot injury in my study.

Due to the preponderance of violence mainly in males, the injuries were commonly seen mainly in males 40(80%) while women injured in 10(20%) cases.

STATISTICALLY THE INJURIES SUSTAINED WERE

INJURY DUE TO	NUMBER OF CASES
Stab injuries with knives	23
Bull gore injuries	19
Sulukki stab injury	2
Wooden pole	1
Arival cut injury	2
Sharp object	2
Ploughing machine	1

Percentage wise, knife stab injuries were the majority forming 46%, with Bull gores coming next with 38% Arival & Wooden pole were of 4% and 2% respectively, and the others were contributing equally to the rest 10%.

In most of the cases, the average time gap between the time of sustaining of injury and time of admission ranged from 1 hour to 6 hours, the delay in some of the cases being due to resuscitatory attempts at local hospitals. The average time taken for most patients to reach the hospital from the time of injury was four hours, with the majority being less than two hours.

The time lapse from the time of admission, in the hospital to the time of laparotomy in our set up has ranged from one hour to eleven hours, the delay

being the time taken for evaluation, resuscitation, and investigation and sometimes due to the O.T. being occupied by other emergency cases.

Upon admission all the patients were assessed regarding the site, size and depth of wounds, all of which were explored under anesthesia prior to laparotomy, excepting those with obvious prolapse of omentum or organs, and those who were in obvious shock at the time of presentation.

The hemodynamic status of the patients was assessed: peripheral pulses, Blood pressure, and consciousness level recorded.

All cases of penetrating trauma of the abdomen in our series were taken up into surgery regardless of hemodynamic status, but a stable patient at the end of six hours since injury denoted that there was no fresh bleeding, even though some collected blood was found due to omental or anterior abdominal wall bleed.

In patients who were subsequently found to have no organ injury at laparotomy, the hemodynamic status was uniformly stable, with Blood pressure and hemoglobin being near normal and with good urine output. These patients numbered 20 and of them, findings were seen in 10 cases, negative laparotomy in 6 cases, minor injuries which could have been managed conservatively in 4 cases. This shows that in hemodynamically stable patients, other findings such as guarding rigidity, abdominal distension, x-ray showing air under diaphragm has to be considered before taking the patient for laparotomy.

Out of a total 50 cases 30 cases presented with unstable hemodynamic status with varying degrees of hypotension, anemia, tachycardia, tachypnoeic, cold extremities, and hypovolemia of which only 2 cases had no significant internal organ injury to abdomen, but had other associated injuries to chest etc.,

In effect, poor hemodynamic status at the time of presentation was a sure indication of visceral injury.

All of the patients presenting with poor hemodynamic status were resuscitated with Intra venous crystalloids with colloids and blood being transfused per (OR) postoperatively for 29 patients, who underwent resection anastomosis, splenectomy, or serious liver injury associated with massive haemoperitoneum.

All the patients had their blood tested for urea and sugar to assess renal perfusion and for anaesthetic purposes. Blood grouping was done for all the patients with 58% of patients receiving blood transfusion.

All the patients with penetrating abdominal trauma had x-ray abdomen in erect posture taken as a base line investigation except in few cases who were hemodynamically unstable.

A surprising feature was the absence of any contributory factor in x-rays in most of the patients having hollow viscus injuries only 12 cases out of 23 cases of hollow viscus perforation, had demonstrable air under the diaphragm and those were the late presenters to the hospital. Several of the

cases with gross haemoperitoneum had ground glass appearance in x-rays. Associated injuries such as rib fractures were made out.

Due to non availability of ultra sound and C.T. For emergency purposes as a routine, these investigations were not done except for few cases.

The mainstay of evaluation was clinical and due to the medico-legal nature of these injuries, all cases were taken for laparotomy regardless of investigations or hemodynamic status, the only criterion being penetration of the peritoneum/ evidence of organ injury.

REGIONWISE DISTRIBUTION:

The site, size and extent of wounds, in these cases were studied. The majority of stabs of abdomen were in the order as:

Lt lower chest with Lt hypochondrium 12(24%)

Umbilical 8(16%)

Epigastric 6(12%)

Rt lower chest with Rt hypochondrium 5(10%)

Lt lumbar 5(10%)

Hypogastric 4(8%)

Rt lumbar 4(8%)

Rt and Lt iliac 4(8%) each

ORGAN WISE DISTRIBUTION OF PENETRATING INJURIES WAS CHARTED OUT, AND THE STATISTICS MADE AS FOLLOWS:

Site of Injury	No of Cases	%	Organs Involved
Epigastric	6	12%	Stomach, Tr Colon, liver, Duodenum, Tr Mesocolon
Umbilical	8	16%	Omentum, small Bowel, Mesentery, Pancreas.
Right Hypochondrium	5	10%	Liver, Stomach, Tr. Colon, gall bladder
Lt hypochondrium	12	24%	Spleen , Stomach
Loin	8	16%	Ileum, Jejunum
Supra Pubic	4	8%	Bladder
Lumbar	9	18%	Ileum, Kidney

Injuries to the stomach and small bowel were the main findings with stomach injuries numbering 7 (14%): small bowel injuries numbering 15 (30%) of which ileal injuries were 9 and jejunal injuries were 4. Liver was the main solid organ injured, numbering 7 cases, of which only 3 was of the higher grade of injuries. Splenic and pancreatic injuries were 3(6%) & 1 (2 %) respectively. Mesenteric injury was mainly associated with other injuries and numbered 6(12%) as also omental injuries which numbered 9 (18%), colonic injuries numbered 7 of which 3 were in the sigmoid and 3 were in the transverse colon, and associated Mesocolic tears were in 2 cases.

Gall bladder injury was found in one case of stab injury (2%) and underwent cholecystectomy. Two cases of duodenal injuries were recorded, both fortunately being of the grade I variety (4%). Bladder injuries numbered 1 (2%) Diaphragm was found injured in 3 cases, one associated with liver injury, one associated with stomach injury, one associated with Lt hemothorax in which injury being a down ward directed stab to the lower chest.

Associated injuries were recorded: majority being stabs to the head injury 2 (4%), clavicle # 2 (4%), chest 6 (12%) back 1, Neck 1, forearm 1 case.

ASSOCIATED INJURIES

REGION	CASES	%
HEAD INJURY	2	4%
CLAVICLE	2	4%
CHEST	6	12%
BACK	1	2%
NECK	1	2%
RADIUS	1	2%

Bone fractures managed by the orthopaedic surgeons, the rest were treated with suturing after debridement. Injuries to chest causing hemopneumothorax were 1 in number, treated with intercostal drain. Injury to chest with associated liver injuries was 4, associated with diaphragmatic tear, and injury chest with splenic injury was recorded in one patient.

All the patients with chest injuries had a difficult post operative period due to respiratory infection which was controlled with antibiotics and chest physiotherapy.

All the 50 patients underwent tetanus prophylaxis and pre and post operative antibiotic cover. Antibiotic coverage include cephalosporin /ampicillin, amikacin/ gentamicin, metronidazole.

OPERATIVE TREATMENT:

Injuries to the liver:

Liver injuries numbered seven in our series, of which 3 were of Gr. II of the liver injury scale and the rest were Gr I, injury. The grade I injuries were found to be either having only a small ooze, or to have completely stopped bleeding by the time laparotomy was performed.

One Gr I injury was treated by hepatorrhaphy, 2 cases were simply left alone, as they were not bleeding.

Of the 3 higher grade injuries, 1 was a case of injury to Lt lobe of liver with devitalized and detached fragments. Patient was resuscitated with blood and colloids, and (L) hepatic lobectomy, hemostasis, and ligation of bleeding vessels in oozing surfaces done, with omental pack sutured to the raw surface of the left lobe. Associated neck injury due to bull gore was repaired.

One other Gr.II case was treated with omental inter position and mattress sutures of chromic catgut. Post operatively these patients had wound infection and prolonged ileus, which settled with conservative expectant management.

One case was found to have a 11 x 6cm tear near the falciform ligament with a depth of more than 2cm, active ooze present. Omental & gel foam pack with perihepatic abdominal packing was done and the abdomen closed since the blood loss was heavy and patient's hemodynamic status was not encouraging to any other primary procedure.

On the 3rd day a relaparotomy was done and the pack removed – bleeding was found arrested but found with focus of gross sepsis. Peritoneal wash given. Higher antibiotic was provided and managed in surgical I.C.U, in spite died on 8th post op period due to septicemia.

Injuries to the Spleen:

There were three cases recorded in our series, 2 due to bull gore injury. One was due to a stab injury of (L) lower intercostal space directed upwards and posteriorly which had entered the Lt chest through the diaphragm (causing a rent in it) after injuring the spleen (Gr 3). Splenectomy was done for that patient, even though the current concept is for splenic conservation, since the wound in the spleen was large and bleeding even after raphy.

The second case was also due to bull gore in the (L) lumbar region extending superiorly, with tear in the spleen near the pedicle, necessitating a splenectomy. This patient had contusion Lt lung which was conservatively managed. Both patients were hemodynamically unstable at the time of admission with Low Blood pressure, tachycardia, Tachypnoeic, dyspnoeic and

pallor, and both cases received pre and per operative Blood transfusion. Third pt managed by splenic conservation.

The post operative period was uneventful expect for respiratory infection which was managed conservatively.

Pancreas:

There was a case of stab injury involving anterior and posterior wall of stomach with penetrating injury of the body of pancreas in which 0.5 x 0.5 cm. Pancreatic duct was not involved, no pancreatic juice leak.

Gall Bladder:

There was one case of Gall bladder injury due to stab wounds in the abdomen in the right hypochondrium. The patient presented with rigidity and guarding of the abdomen x-ray chest was normal and x-ray abdomen revealed no air under the diaphragm.

The patient had abdominal distension with evidence of free fluid in the abdomen four quadrant aspiration was done and bile stained fluid aspirated.

That patient presented with isolated gall bladder injury on exploration and hence the hemodynamic status was stable at the time of admission.

X-ray reveled no diagnostic finding.

Stomach Injuries:

There were a total of 7 cases of stomach injuries.

Total cases of stomach injuries	7	
Isolated stomach injuries	3	uneventful recovery
Stomach with transverse colon	1	uneventful recovery
Stomach with diaphragm	1	died due to ARDS
Stomach with Pancreas	1	uneventful recovery
Stomach with gall bladder & liver	1	uneventful recovery

All the patients who were subsequently found to have had stomach perforations presented with guarding, rigidity and features of peritonitis. All cases except isolated stomach injuries were in hypotensive state.

5 of the cases had air under diaphragm. The rest of the cases had no demonstrable air and had hazy ground glass appearance.

All the 7 patients underwent laparotomy after resuscitation with IV fluids. Blood transfusion was given in 2 cases who had heavy blood loss due to associated liver and other organ injuries.

Most of the wounds were situated in the anterior wall of stomach, through and through injury of stomach body, near the pylorus.

All the wounds were closed in 2 layers. Lesser sac opened in all cases to explore the posterior aspect of stomach and pancreas, and the posterior rent also closed in one case.

Diaphragmatic Injuries:

These numbered three in our series and all were due to lower chest stabs cases.

The pleura, diaphragm and entered the peritoneal cavity. Of the two cases one had liver contusion on Rt lobe which was devitalized for which Rt lobectomy was done and repair of diaphragm was done, in another case there was stomach wall tear which was repaired. The rest of the case had no major organ injury in the abdomen namely one case.

SMALL INTESTINE INJURIES.

Duodenal injuries:

There were two cases of duodenal injuries, one with injury in the second part of duodenum with air under diaphragm, it was Kocherised, the posterior wall was intact ampulla was normal. Primary closure was done and the patient uneventfully recovered. 2nd patient had injury to 4th part of duodenum with associated vascular injury and massive retro peritoneal bleed died 6 hours after surgery.

Jejunal and ileal injuries

They were majority in my series numbering of which 4 were jejunal and 7 were ileal injuries.

All the cases were due to mid abdominal stab wounds and all were subjected to laparotomy.

One Case of jejunal injuries was treated with resection and anastomosis due to mesenteric tear and two lacerated wounds within 15cms with intervening bowel gangrene

Total no of jejunal injuries	4
Isolated jejunal injuries	3
Associated with other injury	1
Resection & anastomosis	1
Wound infection	2

The rest of the cases were treated by simple closure in two layers associated injuries were repaired.

Ileal injuries were 7 in number

All the cases presented with features of peritonitis. Four cases presented with air under the diaphragm

Total cases of ileal injuries	7
Isolated ileal injuries	4
Associated with mesenteric and omental injuries	3
Associated with other organs	1
Resection & anastomosis	2

Post operative follow up of ileal injuries

Burst abdomen	1
Wound gaping	2
Uneventful	4

Post operatively two of the cases had wound infection two of the cases had prolonged abdomen distention and ileus, one case of wound dehiscence which had to be restored secondarily.

There was a case of bull gore injury with ileal injury with omental injury and liver contusion for which repair was done that patient had burst abdomen on fourteenth day for which secondary suturing was done. The patient stayed there for more than 2 months.

The rest of the cases were uneventful post operatively

Both jejunum and ileum were injured in one patient for whom simple closure was done in two layers. Patient recovered uneventfully.

Colonic injuries:

There were 7 cases of colonic injuries of which sigmoid colon and Transverse colon in 3 cases each, one caecus.

The reasons attributed are the free mobility and superficial position of these segments of colon

Regarding caecal injury case the patient presented with a bull gore injury of abdomen, the abdominal wound being in the Rt iliac fossa towards flank of size 2x2cm. With loops of intestine protruding out. The patient presented with shock and was revived.

By a midline incision the abdomen was opened. There was a 1x1cm tear along with caecum with no spillage. Rt limited hemicolectomy was done and the ileum end was anastomosed with the ascending colon for that case. Post operatively the patient was discharged with no ill effects.

Regarding sigmoid colon one case was also due to a bull gore injury situated in the left iliac and lumbar region. The patient was stable at the time of admission.

At laparotomy by left paramedian incision, there was an isolated sigmoid colon injury involving the serosal layer with prolapsed omentum. The tear was sutured and prolapsed omentum excised. Abdomen washed and closed without drains.

Oral feeding was due delayed from routine and the post operative period was uneventful except for superficial wound sepsis.

Second case was due to stab injury Lt iliac region which had two perforations in sigmoid colon closed by two layers using 3-0 vicryl. Patient had wound discharge, which was treated conservatively and discharged on the 11th day.

The third case was bull gore injury with puncture wound of sigmoid colon closed using 3-0 vicryl and postoperative period was uneventful.

Three cases of transverse colon injury have been recorded. All three were due to stab injury. One was associated with liver injury, another with 4th part of duodenum perforation with retroperitoneal injury, another with stomach perforation.

In 3rd case laparotomy was done and there was minimal haemoperitoneum with bile stained fluid. The stomach was found to have a tear in the greater curvature. Transverse colon was found to have been penetrated through & through tear.

All the tears repaired in 2 layers. Drain kept after peritoneal wash.

Post operatively patient had delayed recovery of Bowel movements and wound infection which settled with antibiotics and cleaning and dressing.

The other was due to stab injury with tear in 4th part of duodenum, transverse colon and multiple mesenteric tear with retroperitoneal bleed. After resuscitation tear were corrected inspite of all the above measures the patient expired.

The last case was stab injury in hepatic flexure of colon with grade II liver injury and scalp injury. The colonic injury was corrected by using 3-0

vicryl & other injuries were repaired and the patient was discharged. Of the 7 cases one patient died.

Urinary bladder Injuries:

In my series one case of bladder injuries has been recorded, which was due to bull gore injury. The wound was in the lower abdomen suprapubic part. The case had 3x1cm irregular tear in the superior surface of urinary bladder and it was treated with suture of the bladder rent in two layers with 3-0 vicryl urinary Foley's in situ SPC was not done. The Foley's was there for 14 days and it was removed and patient was discharged.

Other injuries:

Include injury to the mesentery, omentum and Mesocolon. In most of the cases these were associated with other injuries.

Total no of Mesenteric injuries	10
Associated with other injuries	4
Associated with ileal injuries	3
Associated with jejunal injuries	3
Mesenteric injuries causing resection	1
Isolated Mesenteric injuries causing Haemoperitoneum	4

Total no of omental injuries	9
Isolated omental injuries	4
Associated with other organ injuries	5
Total no.mesoclon injuries	2
Cases requiring resection	0
Associated with other injuries	2

All the cases with mesenteric injuries presented with features of shock except the two cases of isolated mesenteric tears, which had caused moderate Haemoperitoneum.

Due to the association with other organs injury feature of peritonitis present in 7 cases with air under diaphragm in three cases.

All cases were subjected to laparotomy after resuscitation a vessels ligated 5 of the cases with Mesenteric tear required blood to associated organ injuries giving rise to massive blood.

All the cases had uneventful post operative period except on injury who had sepsis subsequently, controlled with antibiotics and transfusion.

One case with mesenteric tears was taken up for resection and of ileum due to resultant devascularization of segments.

Omental injuries were 9 in number of which 4 cases with isolated injury to omentum, otherwise negative laparotomies and among the 4 one case had haemoperitoneum. The rest of the cases were 5 in nos and were associated with organ injury. Omentum was found prolapsed in 5 cases.

In all cases, after laparotomy, the prolapsed part of omentum as a septic focuses and hence excised. Bleeding points in the omentum thorough peritoneal toileting done.

There were two cases of injury to mesocolon and both were associated with other injuries.

No vascular deficit resulted from both the cases.

Renal injury:

one case of renal injury is reported in my study, due to bull gore injury to rt flank. Patient had no signs of peritonitis at the time of presentation.pt observed, developed abdominal distension ,CT showed injury to rt kidney,laparotomy done ,midline incision,rt reteroperitoneum entered huge sub capsular hematoma with laceration of rt kidney gr (3), present, hematoma evacuated ,debrided & sutured.patient discharged uneventfully on the 24th day.

Death

4cases died during my study period.

1.Old lady with ploughing machine injury with extensive loss of anterior abdominal wall presented with shock, revived, post operatively in ventilator support died on the 8th day due to ARDS

2.40 yr old male with bull gore injury with associated blunt injury chest with massive lung contusion, in shock, revived, Lt ICD done, on laparotomy was found to have diaphragmatic injury, stomach injury ,post operatively on ventillatory support ,died on the 3rd day due to ARDS.

3. Stab injury-45/m presented with shock, revived, on laparotomy, Grade 3 liver injury –perihepatic packing done-relaparotomy done .pt died on the 8th day due to multi organ failure

4. 34yr male with stab injury, with massive intra & retro peritoneal bleed, multiple mesenteric lacerations with transverse colon & duodenal 4th part injury, with no solid organ injury died within hours due to massive bleed.

DISCUSSION

The current study includes the observation made in 50 cases admitted with penetrating trauma with visceral injury.

Six cases were in the age group of 10 to 20 years which accounts for 12% of cases. Thirty cases were in the age group of 20 to 40 years of age which accounted for 60% of cases, while thirteen cases, forming 26% of cases were in the age of 40-60 years of age. Above 60 years of age, one case was recorded forming 2% of total cases.

Males: Female ratio was 4:1 i.e., 80% of cases were male and 20% were female.

The increased incidence in males is probably due to outdoor nature of occupation and aggressive behavior in males. More over most of the patients had alcoholic breath smell during admission.

The age distribution shows that males of age group 20 to 60 exhibit maximal aggressive behavior while extremes of age , though lesser in number(12% and 2% on both extremes) are no exceptions to being victims of violence.

Regarding the mode of violence, in my study, the commonest mode of injury was due to assault which occurred in twenty nine cases forming 58% and accidental injury including bull gore injuries numbering nineteen, accounting for 38% of injuries.

The favorite weapon of assault includes knife, ranging from penknife to the pitchuvas, Sulukki and arival. Knife injuries accounted for 23 cases (46%),

arrival 2(4%), Sulukki 2(4%), wooden pole 1 (2%), others 2(4%) cases each. bull gore accounted for 19 cases (38%).

Accidental injuries include Road traffic accidents of low velocity with penetration by sharp articles such as steel pylons, or rods being carried in vehicles, which account for 2 cases and accidental fall over a ploughing machine and sharp object accounting for 1 case each.

PENETRATING INJURY

Common sites of injury were Epigastric in 6 cases (12%) umbilical area 10(20%), hypogastric area 2(4%), Rt hypochondrium 5(10%), Lt hypochondrium 12(24%), lumbar 9(18%), iliac region 6(12%).

Regarding the significance of site of injury to organ injury, Epigastric has caused stomach, Transverse colon, mesocolon, liver, duodenum and omental injury, umbilical region leads to injuries of small bowel document pancreas and omentum, Rt. Hypochondrial injuries mainly caused injuries to stomach, liver and Transverse colon, Lt Sub costal injuries caused stomach and splenic lacerations, Loin injuries caused small bowel injuries, renal injury suprapubic injuries caused bladder tears Low chest stabs caused Diaphragmatic tears with liver or splenic injuries.

These are given in the adjoining chart.

At the time of admission, 20(40%) of the 50 patients were hemodynamically, stable though exhibiting signs of peritonitis and 30 of the

patients (60%) were unstable with signs of hypo perfusion, hemorrhage, hypotension etc, making rapid resuscitation mandatory.

Treatment in the form of resuscitation and surgery was instituted to all patients immediately after admission.

Preoperative physical examination showed that all the patients had varying degrees of abdominal distension, with guarding and rigidity in all cases. Bowel sounds were heard at the time of admission in majority of patients.

Associated injuries were chest stabs in 6 cases (12%) with stab injuries to the neck, Forearm, and back also being seen.

Fractures involving the ribs were seen in two cases of stab injuries.

So called negative laparotomies in which no or insignificant injury was seen at laparotomy were seen in 6 cases (12%) of which bull gores formed 4 cases, and that with pen knife were the cause in one case and accidental injury one case.

All those 6 cases presented with stable hemodynamic status and were suitable candidates for observation and conservative management, but as proved by an extensive study conducted by the department of emergency medicine, Carolinas Medical Centre, Charlotte, North Carolina, and as per their conclusion, "The desire to avoid unnecessary laparotomy is laudable. Nevertheless, marked morbidity or mortality caused by failure to conduct laparotomy in a timely manner can be a dreaded consequence. When clinical and diagnostic studies are unable to resolve the presence or severity of injury,

laparotomy is often more prudent than expectant observation” (Marx J.A. et al in Emerg. Med. Chin. Northam 1993 (Feb: 11 (1): 125-35).

Also the cases had medico legal implications and due to non availability of sophisticated aids such as C-T, and ultrasound for emergency cases, reliance was made on a protocol of “physical examination, wound exploration, peritoneal tap/lavage and ancillary diagnostic studies as applicable” as suggested by Mc. Carthy, Lowdermilk and Broadie in the study as published in Archives of surgery 1991, Ag(126(8):962-5.

They were of limited use diagnostically and were mainly for anaesthetic assessment and for resuscitation for surgery.

X-ray abdomen in erect posture has limited role even in diagnosing hollow viscus injury especially in early period out of 23 hollow viscus only 12 showed air under diaphragm.

Diagnostic peritoneal lavage, which is considered upto 90% positive in cases of blunt injury abdomen, has been recorded to be reliable in only 36 to 40% (Powell, Root et al 1982) having a high false positive rate due to blood from extra peritoneal success.

In our series, DPL was not done as a routine and 4 quadrant aspiration was done in cases having Rt and Lt hypochondrial injuries with suspected liver and splenic involvement with positive results of upto 70%.

X-rays of chest demonstrated associated pleural and lung injuries.

Laparotomy was done in all the 50 cases having the sole criteria of penetration of peritoneum.

Post-operative period of all the 50 cases were followed up rigorously.

POST-OPERATIVE EVENTS	NO OF CASES
Superficial wound infection.	12
Expired	4
Post-operative fever	9
Burst abdomen with low output fistula with Pelvic abscess	1
Resuturing	3

All the cases of resection with anastomosis and all the cases with multiple organ injury and those with peritoneal soiling had ileus with abdominal distension which settled after continuous Nasogastric aspiration with IVF AND Antibiotics.

Post-operative fever was due to infection, and 3 cases went on to dehiscence and had to be repaired secondarily.

All the cases of chest injury with ICD went on to have respiratory infection and fever which settled after removal of the tubes and administering higher antibiotics.

One cases of residual pelvic abscess was drained via the rectum and subsequently the fever, ileus and abdominal distension settled down.

All the cases of superficial wound infection settled with daily dressing and change of antibiotics.

Death 4 cases

2 stab injury, 1 bull gore & 1 ploughing machine injury

All these pts were presented with very bad general condition

All patients operated post operatively all were in ventilatory support.

CONCLUSION

- 1) The commonest cause of penetrating injury in our study is stab injury with knife and the next comes the bull gore injuries. This is consistent with other studies conducted in similar semi Urban centers like Vellore.
- 2) Similar to many large series males are more often affected by penetrating abdominal trauma than females and middle aged persons are the most involved than at either extremes of age.
- 3) Earlier the resuscitation and laparotomy, the better the results of surgery and better the prognosis.
- 4) The commonest intra abdominal organs to be injured are the hollow viscera namely small bowel, and stomach, followed by liver injuries.
- 5) Commonest associated injury in our study was chest injuries followed by forearm and other injuries. Fractures were rare and mainly confined to ribs.
- 6) Early laparotomy after thorough clinical evaluation and good resuscitation with methodical exploratory techniques is essential for total diagnosis and management of various intra abdominal organ injury, so as not to miss any injury.
- 7) Investigation such as x-rays and Blood tests are only complementary to clinical examination and wound exploration.
- 8) The desire to avoid unnecessary laparotomy is laudable. Nevertheless marked morbidity or mortality caused by failure to conduct laparotomy in a timely manner can be a dreaded consequence. When clinical and diagnostic

studies are unable to resolve the presence or severity of injuries, laparotomy is often more prudent than expectant observation.

9) Routine use of peri-operative antibiotics reduces the rate of post-operative infection and morbidity.

10) Cases that were discharged with minor complications were 12(24%).

11) Cases that were discharged with major complications were 3(6%).

12) In spite of all above measures about 4(8%) were death cases.

13) Cases that were discharged were 31(62%) uneventfully.

14) Of the 50 cases 6(12%) were negative laparotomies without any organ or omental or mesenteric injury.

15) Thorough peritoneal wash with normal saline and drainage gives good post-operative results.

16) Morbidity and mortality is more in multiple organ injuries than in isolated organ injury.

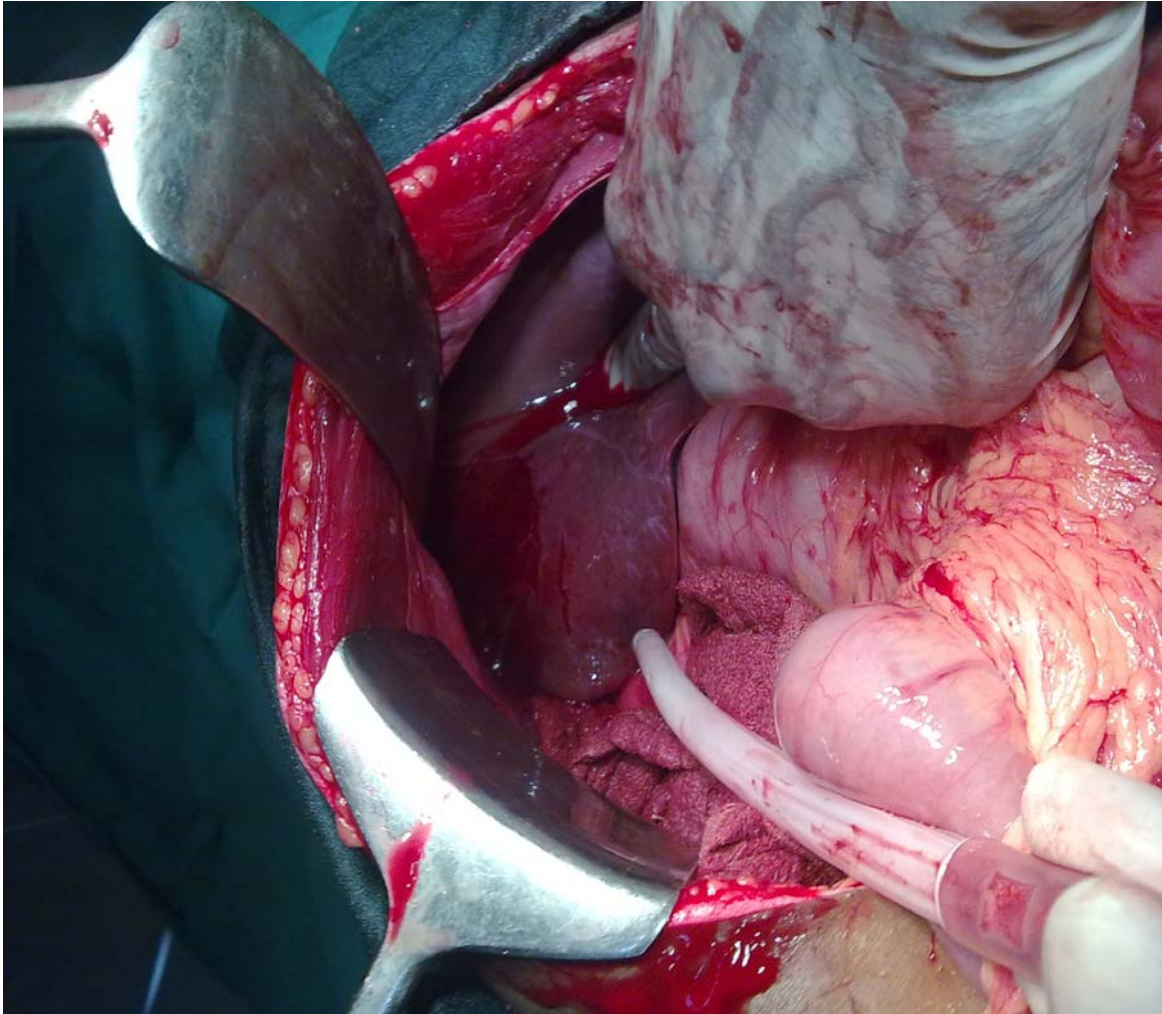
17) Unstable hemodynamic status at the time of admission should be taken as a definitive indication for laparotomy since no cases were negative on laparotomy

18) Lt hypochondrium stab wounds cause the maximum damage to intra abdominal organs.

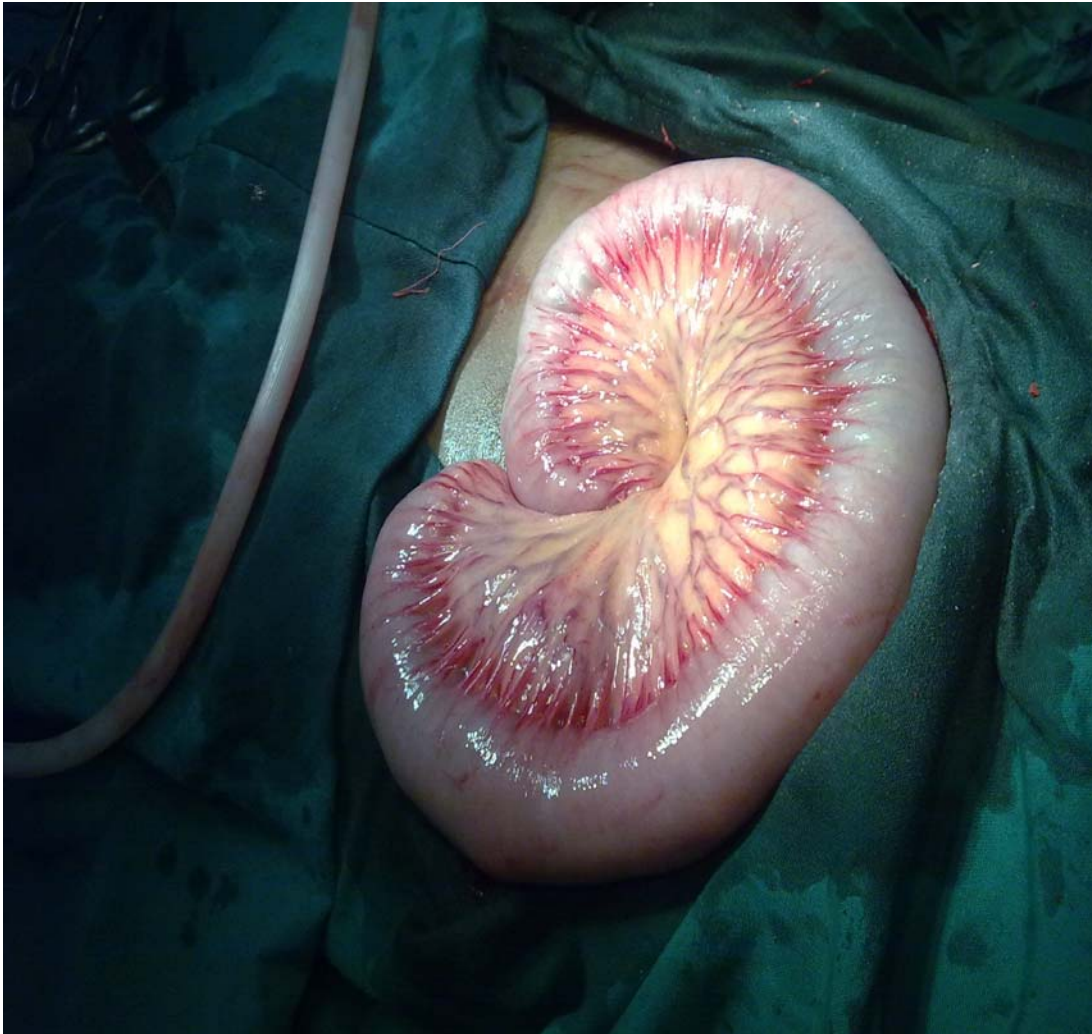
19) Regarding laparoscopy, We have not started to employ Laparoscopy as an aid to confirmation to non availability of trained personnel.



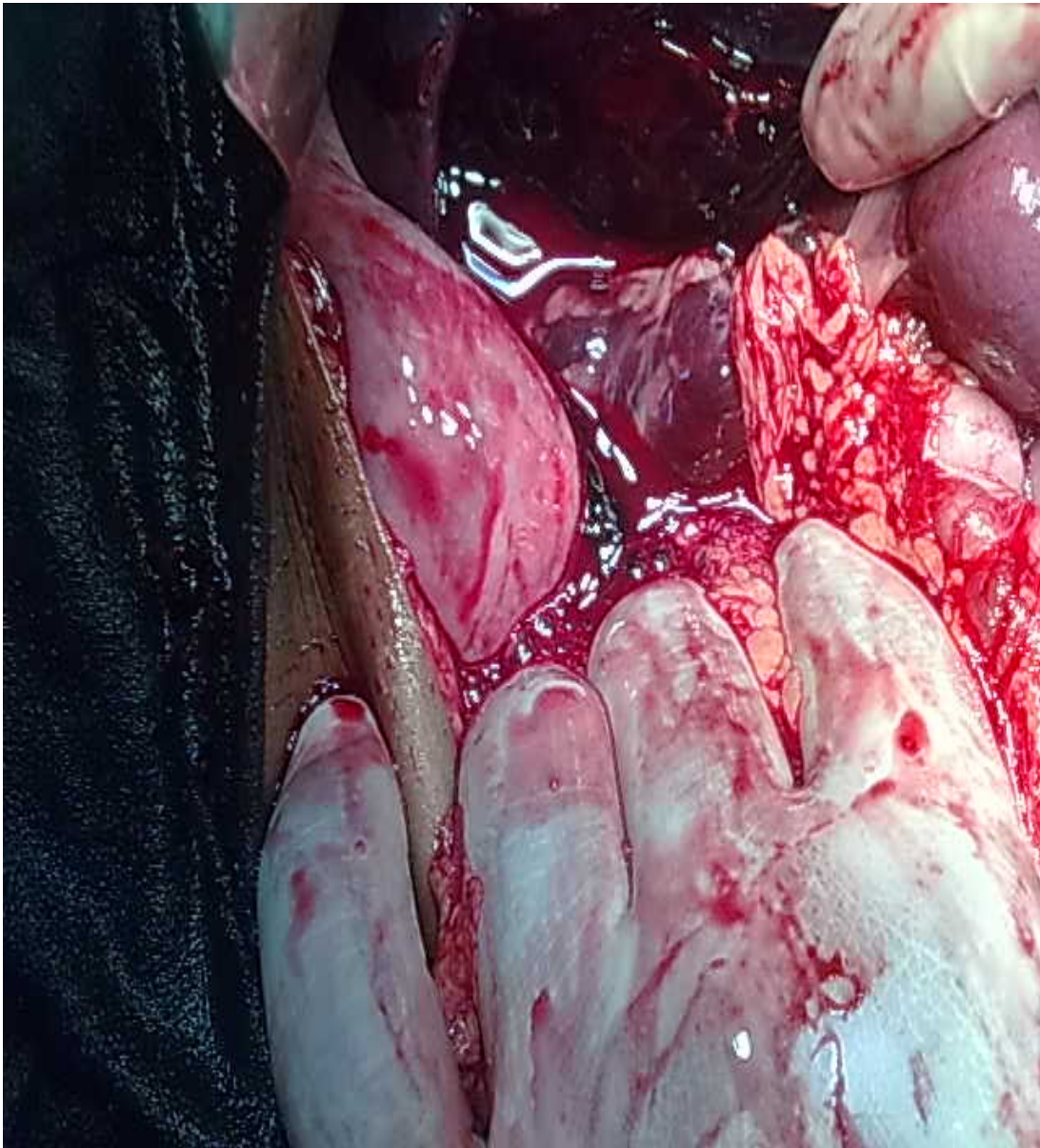
STAB INJURY RT LOWER CHEST



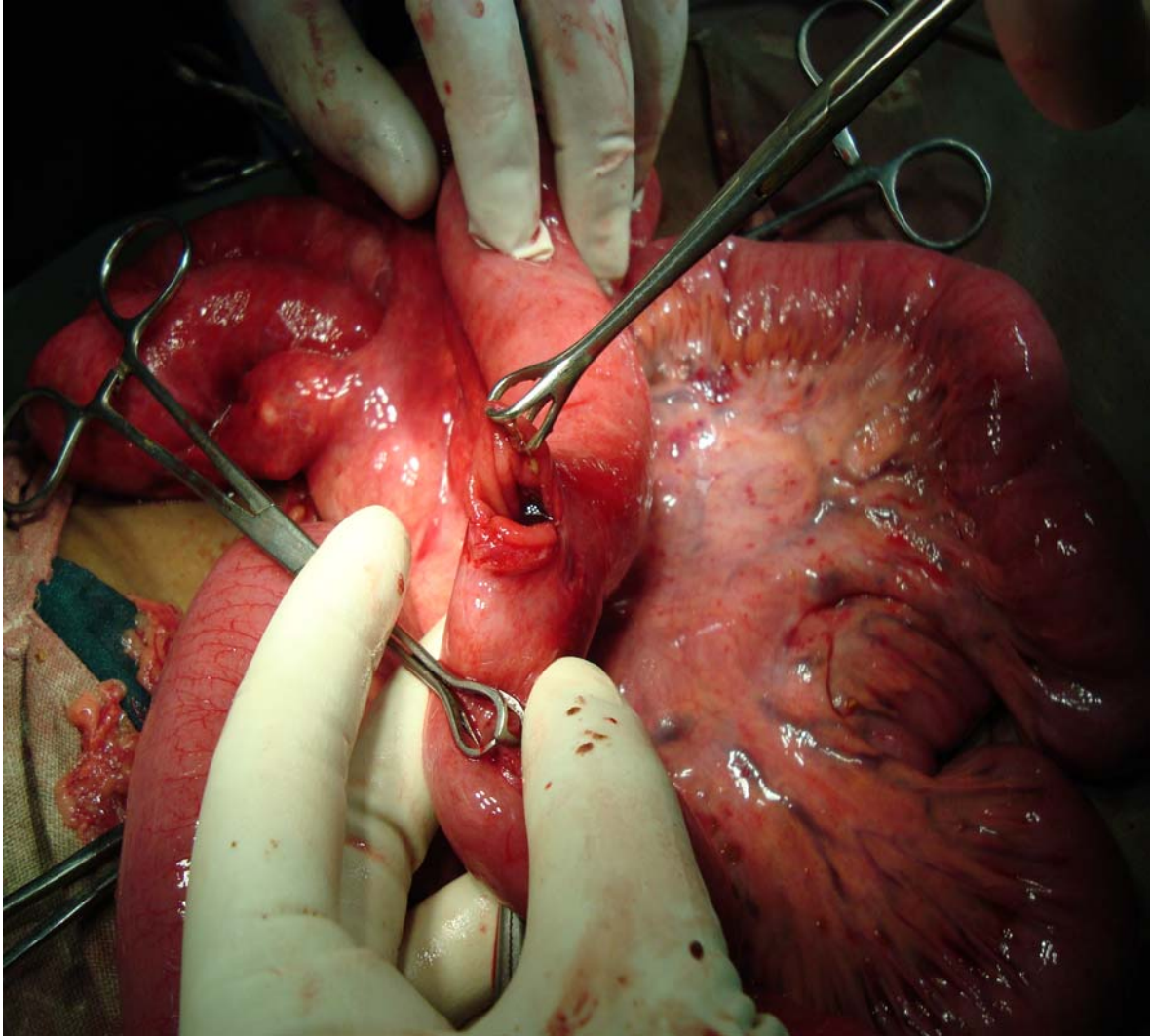
GRADE I LIVER INJURY



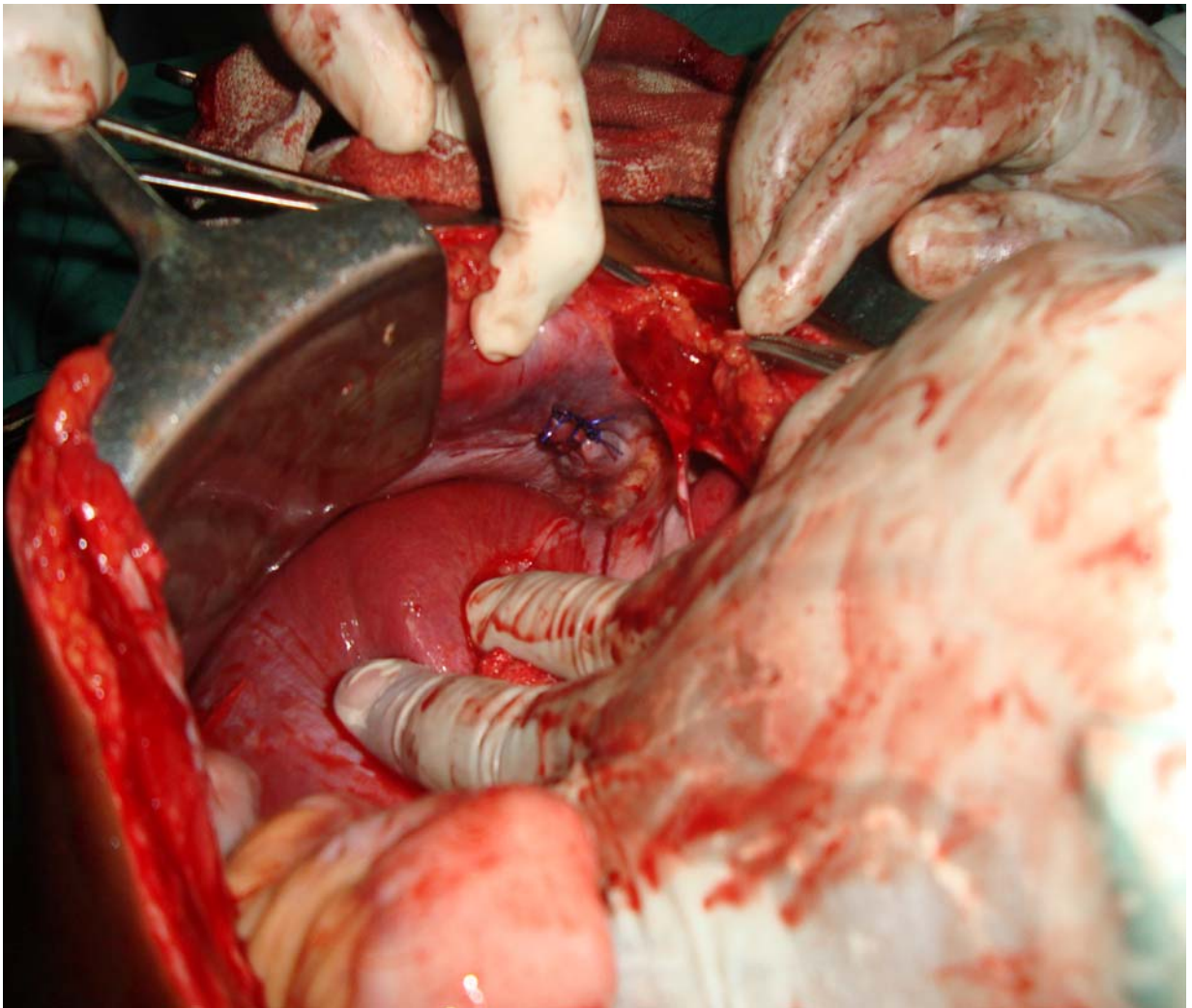
JEJUNAL PROLAPSE



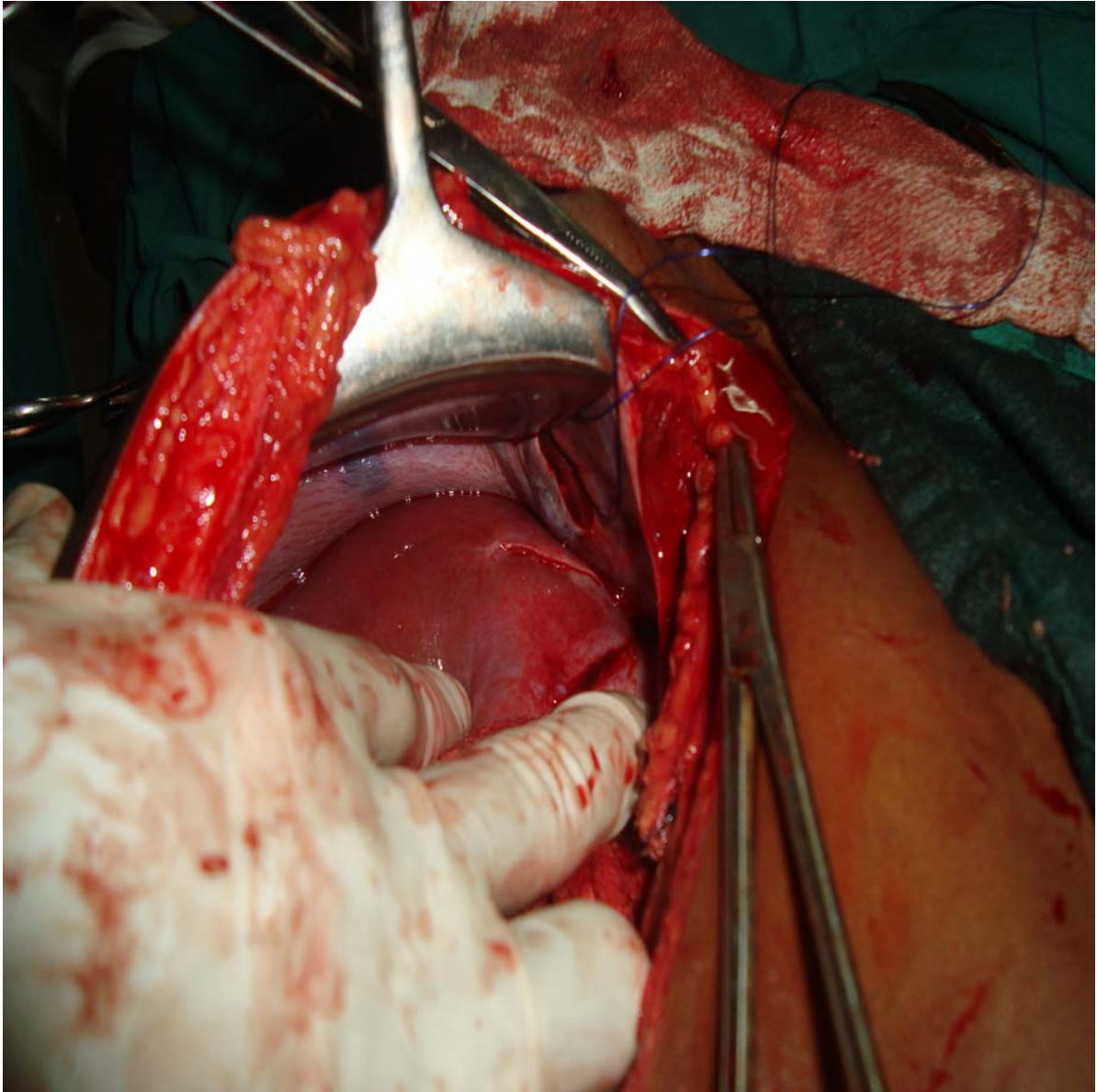
HAEMO PERITONEUM



ILEAL TEAR



DIAPHRAGM INJURY REPAIRED WITH PROLENE SUTURES

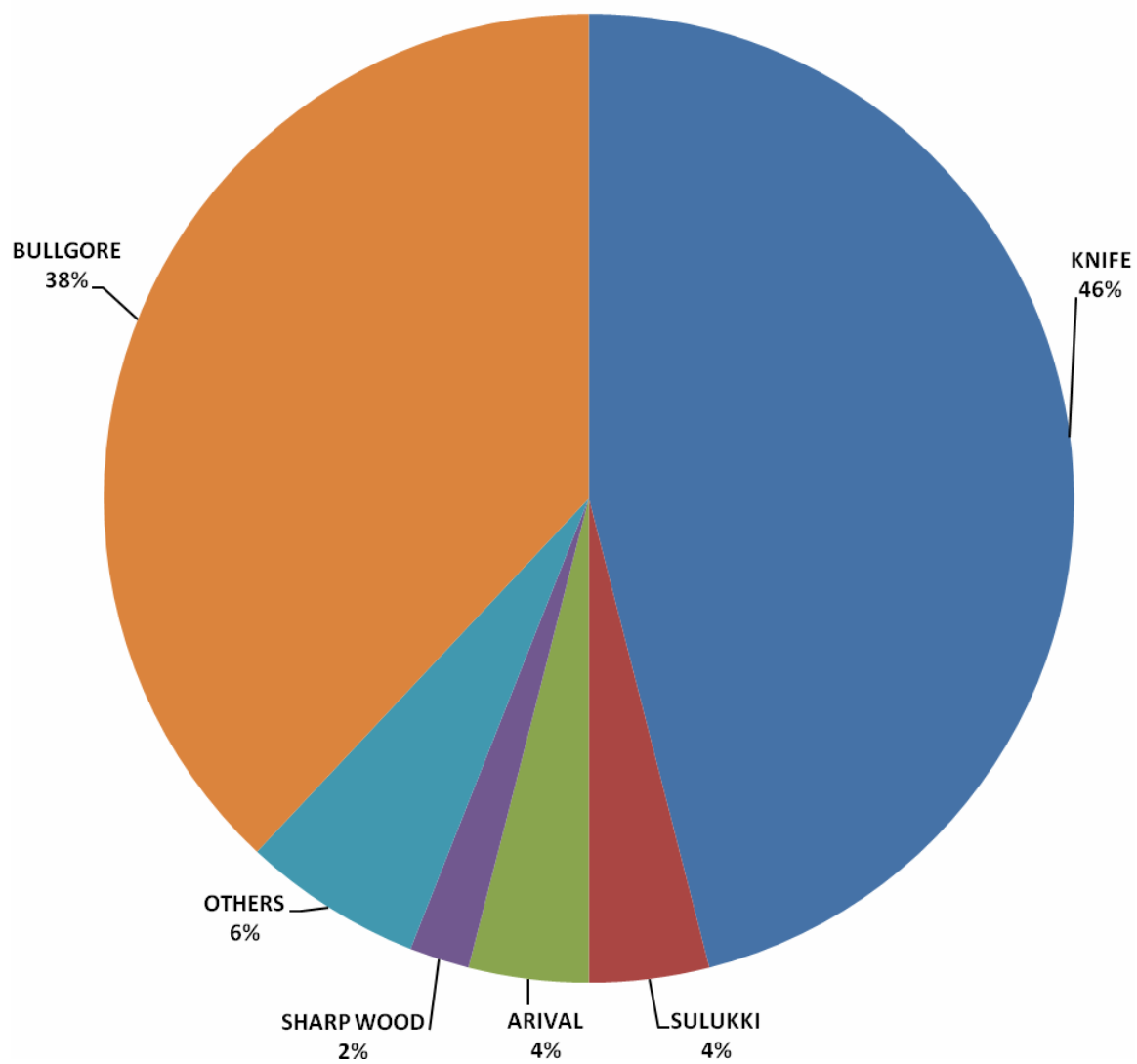


DIAPHRAGMATIC INJURY WITH GRADE I LIVER LACERATION

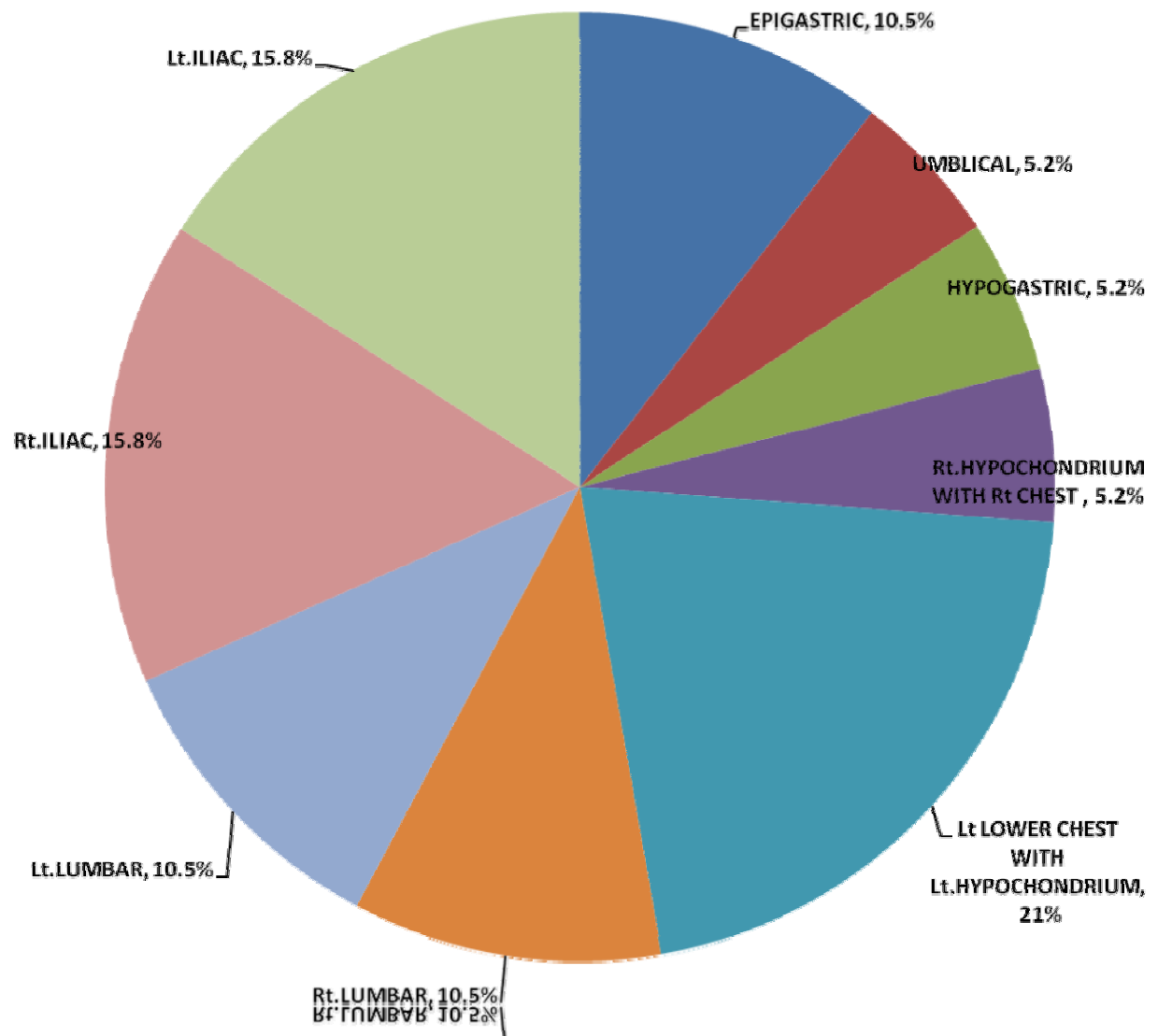


INTESTINE PROLAPSE

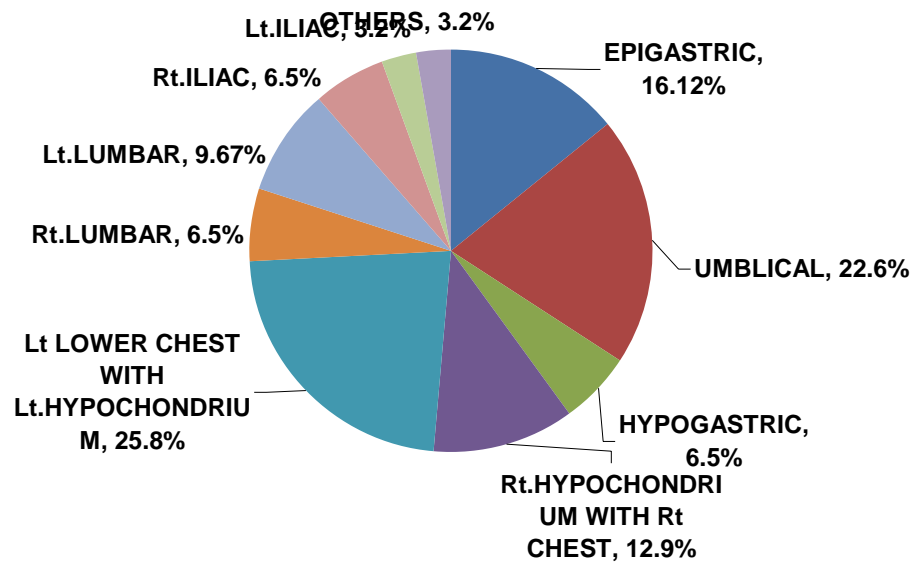
WEAPON USED



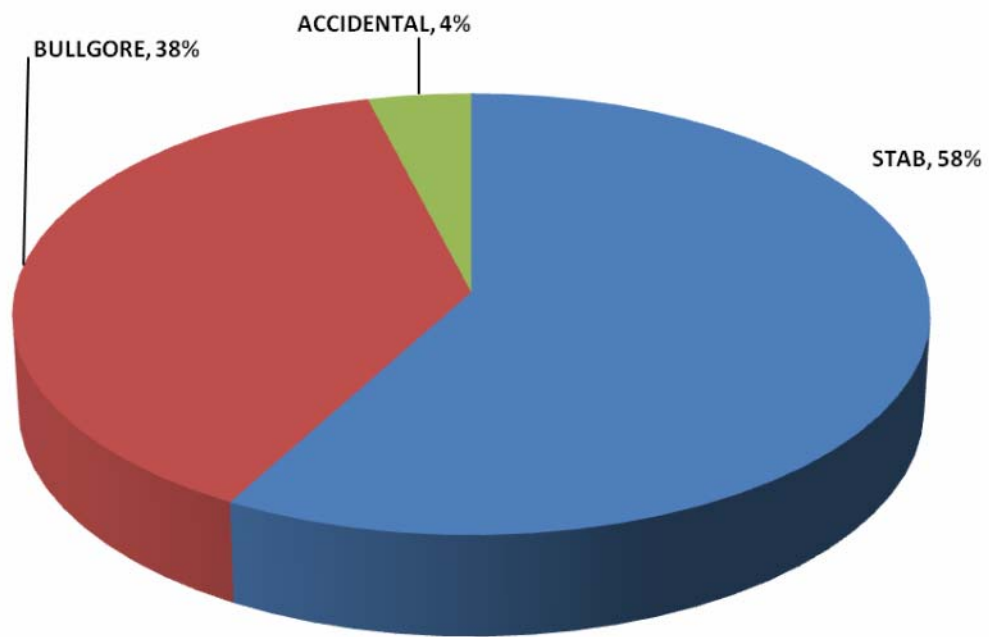
AREAS OF PENETRATING INJURY- BULLGORE



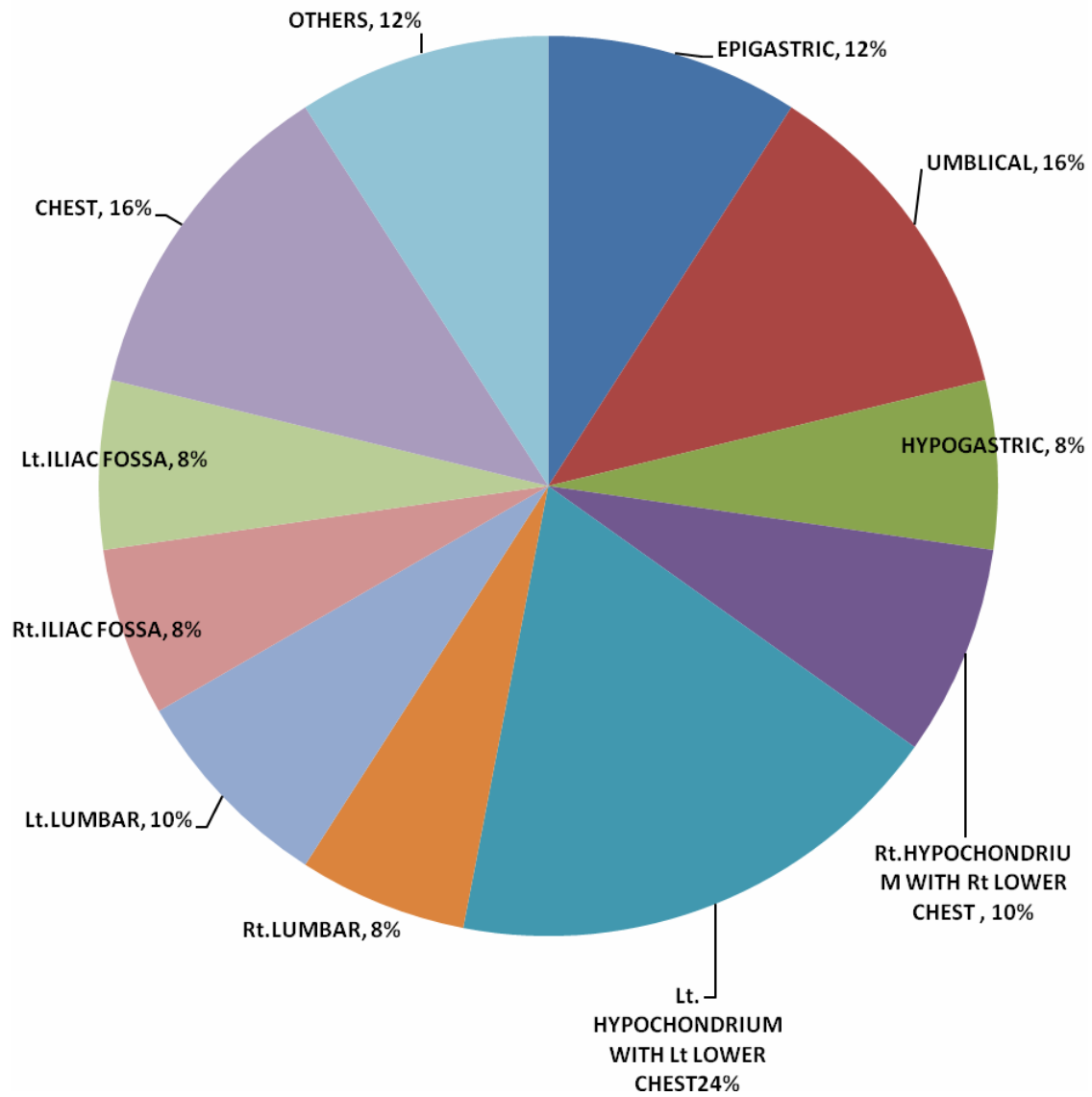
AREAS OF PENETRATING INJURY- STAB INJURY

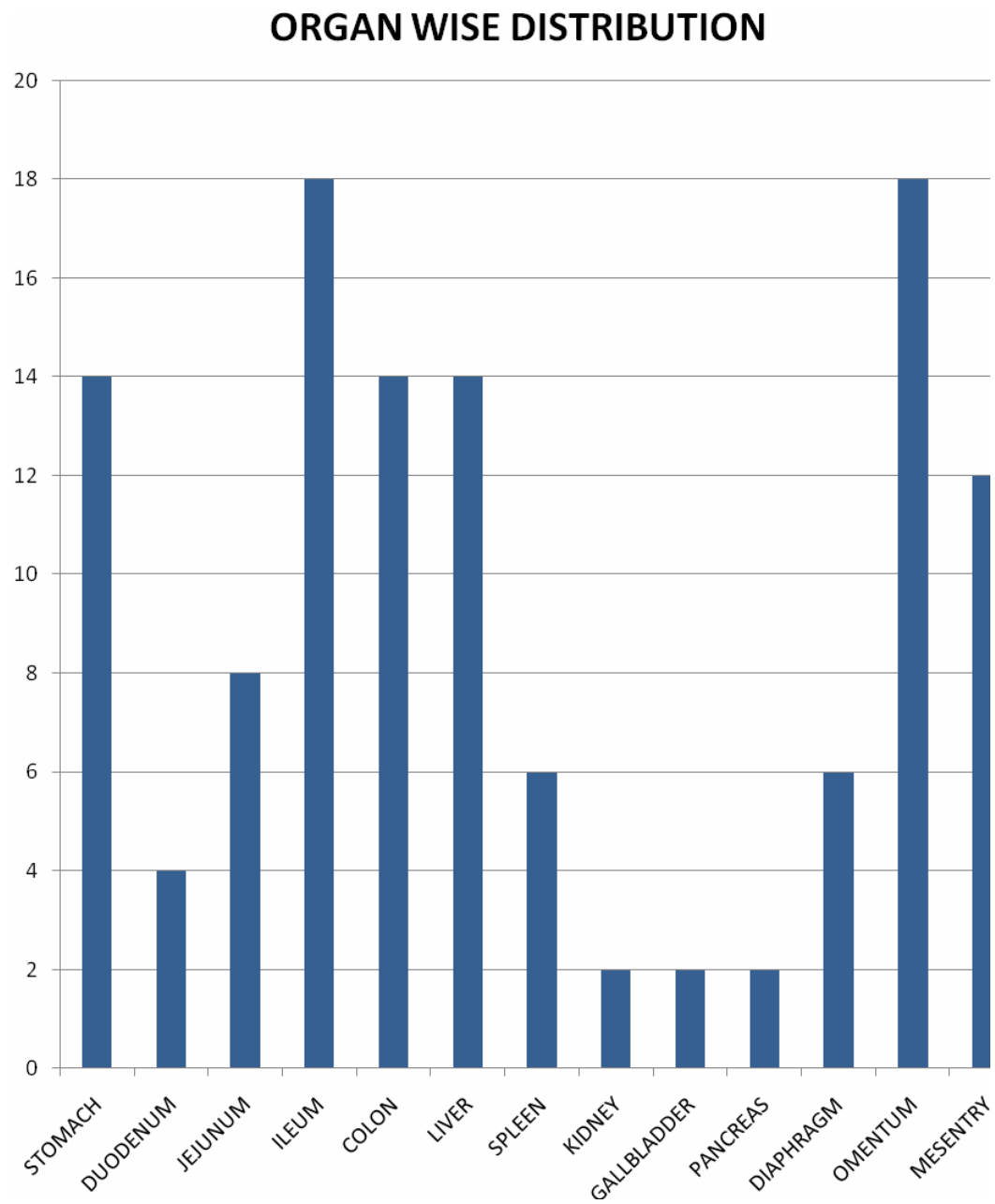


MODE OF INJURY

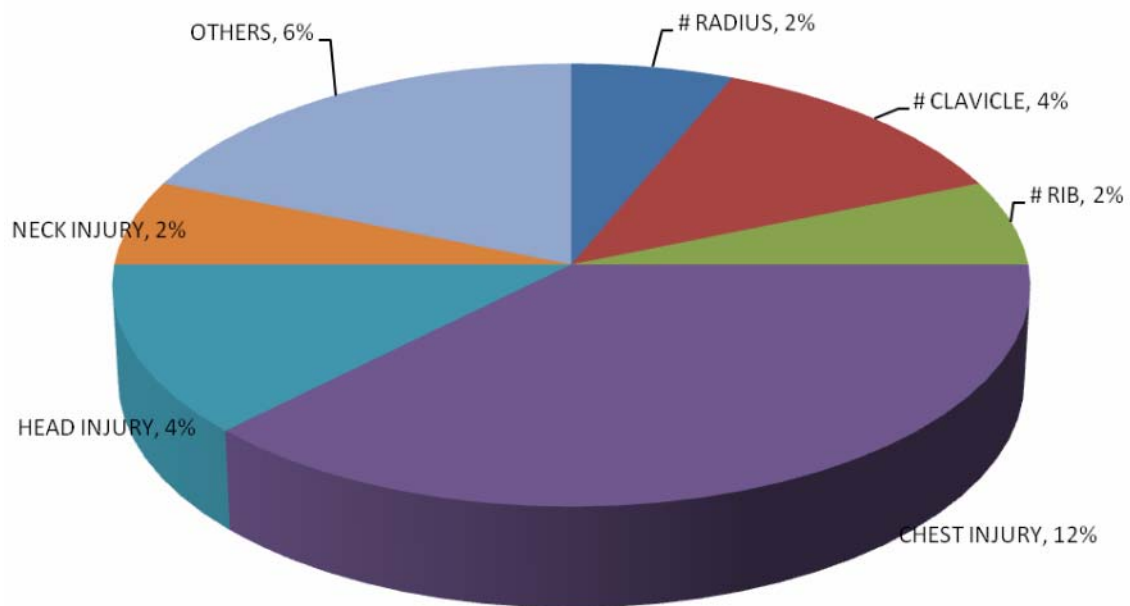


AREAS OF PENETRATING INJURY - TOTAL

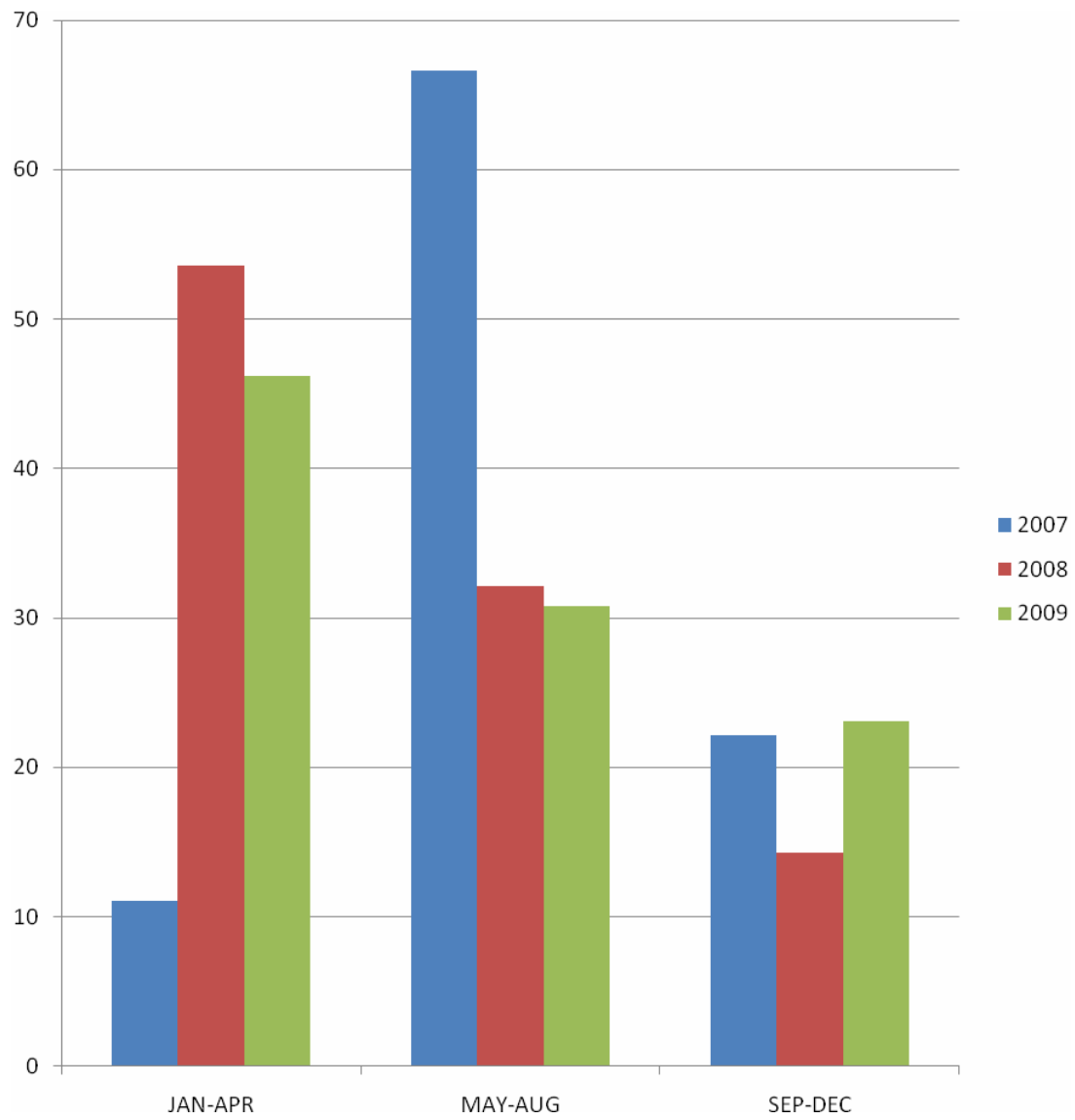




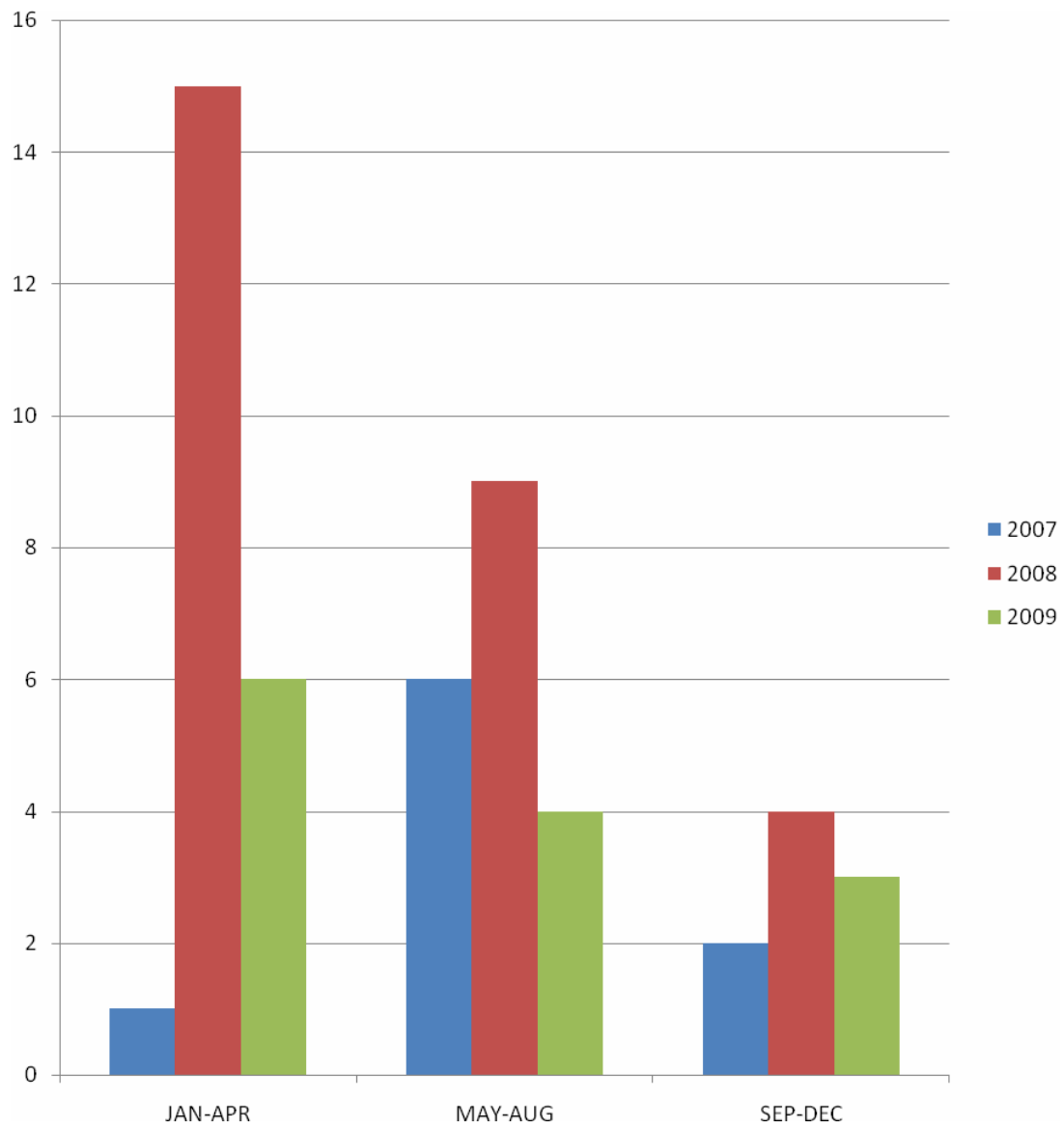
ASSOCIATED INJURIES



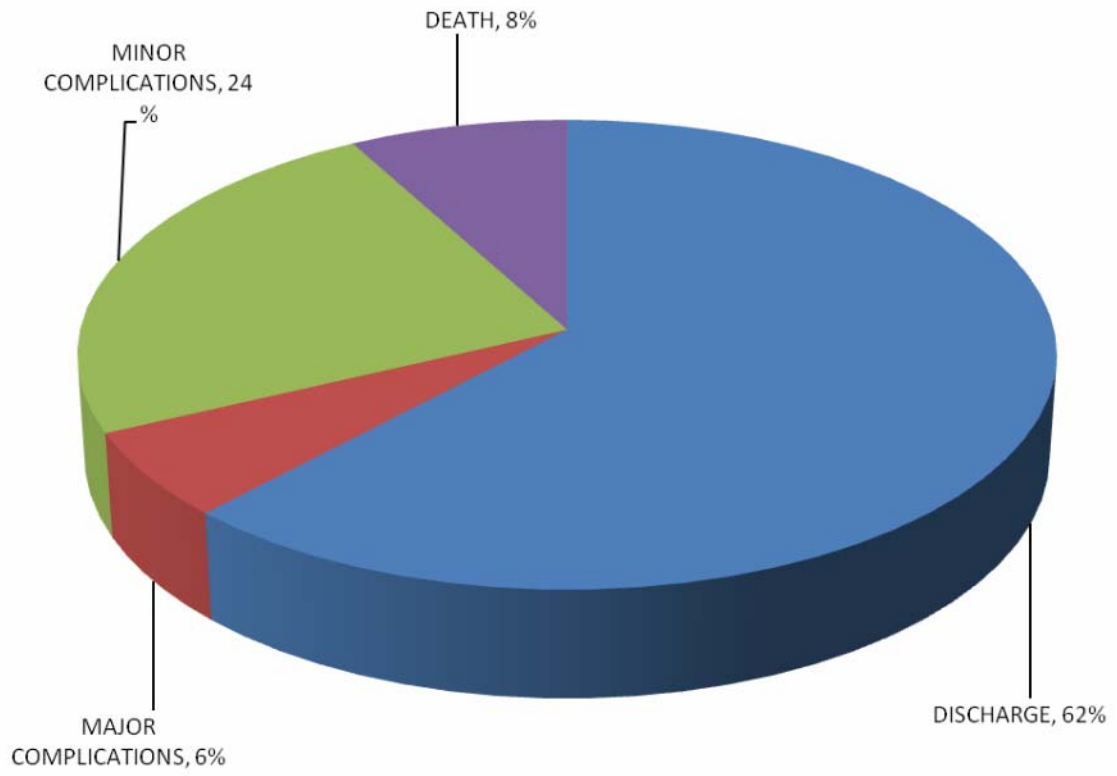
SEASONAL VARIATION



SEASONAL VARIATION

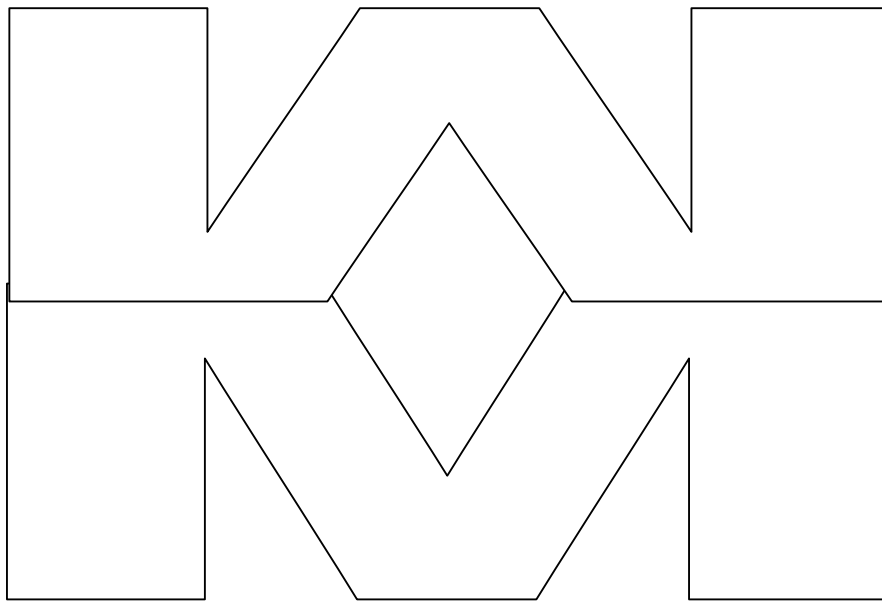


OUTCOME



EVALUATION OF PATIENTS WITH PENETRATING INJURY TO ABDOMINAL ORGANS

MASTER CHART



OUTCOME OF UNSTABLE PATIENTS

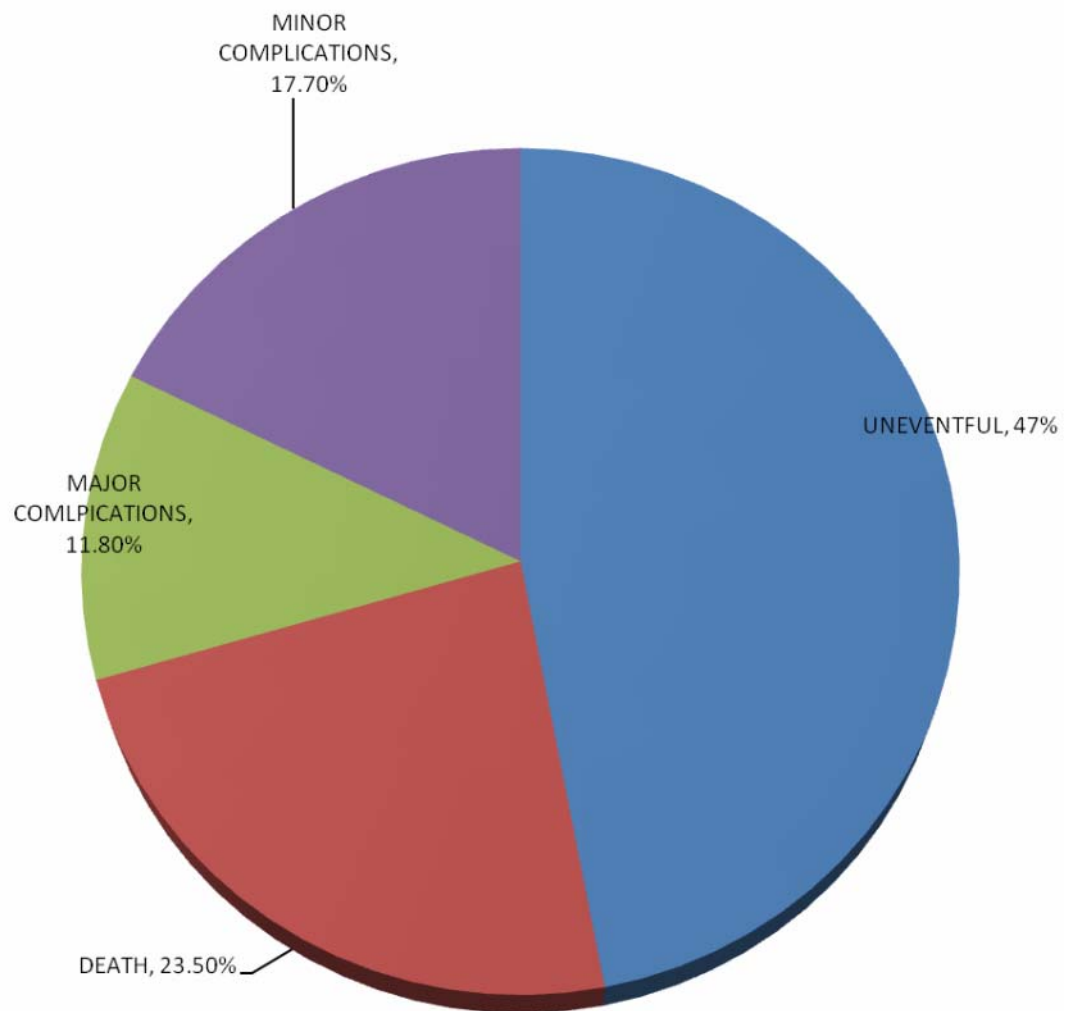


Table-1 - Splenic injury scale

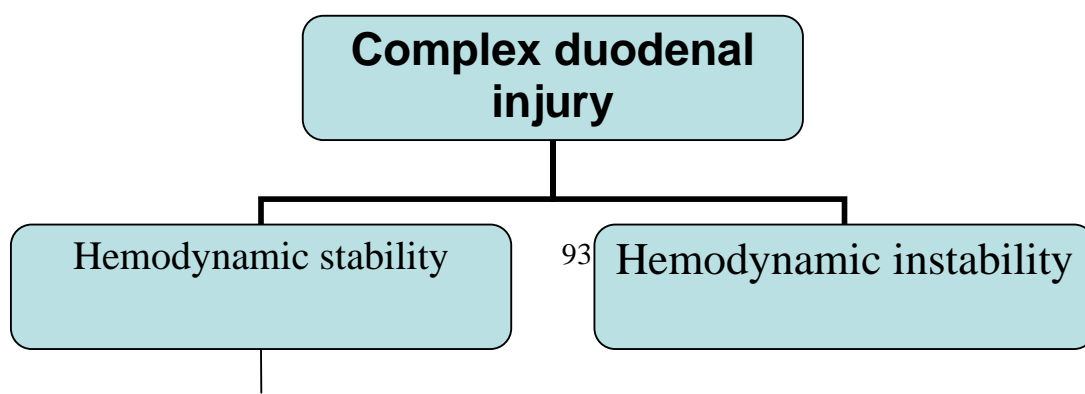
Sl.No	Grade	Injury Description
1.	Hematoma Laceration	Sub capsular, nonexpanding surface area <10% Capsular tear non bleeding parenchymal depth < 1 cm
2.	Hematoma Laceration	Sub capsular, nonexpanding surface area 10-50 % Intra parenchymal, nonexpanding < 2 cm in diameter Capsular tear active bleeding
3.	Hematoma Laceration	Sub capsular, > 50% surface area or expanding Ruptured sub capsular Hematoma active bleeding intra parenchymal, hematoma > 2 cm or expanding > 3 cm parenchymal depth or involving trabecular vessels
4.	Hematoma Laceration	Ruptured intra parenchymal hematoma with active bleeding Laceration involving segmental or hilar vessels producing major devascularization (> 25% of spleen)
5.	Laceration Vascular	Completely shattered spleen Hilar vascular injury that devascularizes spleen

Table-2-Liver injury grading

S.No	Grader	Injury Description

I	Hematoma Laceration	Sub capsular, < 10% surface area Capsular tear, < 1 cm parenchymal depth
II	Hematoma Laceration	Sub capsular, < 10% - 50% surface area Intra parenchymal < 10 cm in diameter parenchymal depth, 1-3 cm in length
III	Hematoma Laceration	Sub capsular, > 50% surface area or expanding, ruptured subs capsular or parenchymal hematoma Intra parenchymal hematoma > 10 cm or expanding > 3 cm parenchymal depth.
IV	Laceration	Parenchymal disruption involving 25%-75% of hepatic lobe or 1-3 couinaud's segments within a single lobe
V	Laceration Vascular	Parenchymal disruption involving > 75% of hepatic lobe or > 3 couinaud's segments within a single lobe juxta hepatic venous injuries i.e. retro hepatic vena cava/central major hepatic veins
VI	Vascular	Hepatic avulsion

Table -5 ALGORITHMS FOR MANAGEMENT OF DUODENAL INJURY



<p>Associated duodenal injury</p> <p>Primary closure after debridement of resection and EEA</p> <p>For large defects</p> <p>Pyloric exclusion (rarely)</p>	<p>Damage Control</p> <p>Hemo control</p> <p>Packing</p> <p>Rapid closure of Perforators</p> <p>ICU resuscitation</p> <p>At repeat laparotomy</p>
<p>B. Combined pancreatico-duodenal injuries</p> <p>Grade III duodenal and pancreatic injuries:</p> <p>Duodenal repair/ resection and EEA, distal pancreatectomy exclusion</p> <p>Grade IV, V duodenal and pancreatic injuries (One or two stage)</p> <p>(One or two stage)</p>	

Table -4- DUODENAL INJURY SEVERITY(

Grade	Injury	Description
I	Hematoma	Single portion of duodenum
	Laceration	Partial thickness only

II	Hematoma Laceration	Involving more than one portion Disruption 2% circumference
III	Laceration	Disruption 5%-75% circumference of D2 Disruption 50%-100% circumference of D1,D3,D4
IV	Laceration	Disruption 75% circumference of D2 Involving ampulla or distal common duct
V	Laceration	Massive disruption of duodenopancreatic complex with. Devascularization of duodenum

AAST ORGAN INJURY SCALING COMMITTEE)

Table-3
PANCREATIC INJURY SCALE

GRADE	GRADE DESCRIPTION ICD-9 AIS-90
I	Minor contusion without duct injury Superficial laceration

II	Major contusion without duct injury or tissue loss. Major laceration without duct injury or tissue loss.
III	Distal transection or parenchymal injury with duct injury.
IV	Proximal transection or parenchymal injury involving ampulla.
V	Massive disruption of pancreatic head